Datex-Ohmeda
Anesthesia Delivery Unit S/5

Anesthesia Delivery Unit AS/3

Technical Reference Manual

0086
Conformity according to the Council Directive 93/42/EEC concerning Medical Devices

All specifications are subject to change without notice.

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1 ABOUT THIS MANUAL

This Technical Reference Manual contains information required to service and repair the Datex-Ohmeda S/5 Anesthesia Delivery Unit and AS/3 Anesthesia Delivery Unit from ID: No 40 000 000 and onwards. It is intended for service personnel and engineers who will perform service and maintenance procedures.

Throughout this manual the S/5 Anesthesia Delivery Unit and AS/3 Anesthesia Delivery Unit will be referred to as the ADU.

The file is divided into sections from 1 to 10 concerning maintenance, and into sections from A to D concerning the ADU modules.

The complete file has a document number shown at the first page, used for example when ordering a copy. The sections 1-10 together have a document number shown in the footer, as well as chapter A, B, C and D. This is to simplify the updating process in the future.

Disclaimer

The manufacturer reserves the right to make changes in product specifications without prior notice. The information in this manual is believed to be accurate and reliable; however, the manufacturer assumes no responsibility for its use.

Related documents

In addition to this Technical Reference Manual, the following documents are available for the ADU.

Open me first

The *"Open me first"* package is located in the delivery package and includes unpacking instructions and the *"ADU Production Card"*, which must be saved in your device history records. The Production Card includes for example, all the necessary order, version and serial number information.

User's Reference Manual

The *"User's Reference Manual"* contains detailed instructions and references for operating the ADU. Everyday cleaning and maintenance procedures as well as simple troubleshooting hints are also included.

System guide

The *"System guide"* provides information on how to select products for configuring a delivery system that fulfils specific needs.

Spare part installation instructions

This manual does not include all instructions for installation of spareparts. Detailed instructions are generally enclosed to the sparepart packages.

Definition of text styles

Names of touch keys are entered in a larger and bold typeface, for example **Setup**

Software menu items are entered in bold italic typeface, for example ***Checks.***

Menu access is described from top to bottom. For example, the selection of the ***Start test*** command from the ***Display*** submenu of the ***Checks*** menu, would be written as ***Checks-Display-Start test***.

Messages (alarm messages, informative messages) displayed on the screen are entered inside single quotes, for example 'Please wait'.

When referring to different documents, sections or paragraphs, the name is entered in italic typeface and enclosed in double quotes, for example *"Installation instructions"*.

Trademarks

Datex-Ohmeda is a registered trademark of Instrumentarium Corp., Helsinki, Finland.

Datex-Ohmeda S/5, AS/3, Aladin, ComWheel, D-Lite, Pedi-Lite, D-Fend, Flexima, Capnomac Ultima, QuickCal, Side Stream Spirometry and Patient Spirometry are trademarks (TM) of Instrumentarium Corp., Finland.

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2 SAFETY

Intended use

The Anesthesia Delivery Unit (ADU) is designed to administer anesthetic breathing gas in manual or mechanical ventilation modes to patients undergoing anesthesia. It is intended for all patient categories.

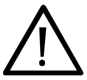
General requirements

The ADU is only to be operated by, or on the order of, a physician.

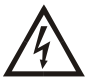
Installation and service of the ADU is only to be done by trained service personnel with proper tools and test equipment. The ADU must be connected to mains electrical power and gas supplies which meet the requirements specified in the *"Technical Specifications" section.*

Read the *"User's Reference Manual"* and the *"Technical Reference Manual"* before performing service to the ADU.

Safety symbols on the equipment



Attention! Consult the accompanying documents!



Dangerous voltage

Responsibility of the user

This product will perform in conformity with the description thereof contained in this manual and accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided. This product must be checked periodically. A defective product should not be used. Parts that are broken, missing plainly worn, distorted, or contaminated should be replaced immediately. Should repair or replacement become necessary, Datex-Ohmeda recommends that a telephonic or written request for service advice be made to the nearest Datex-Ohmeda Field Service Support center. This product or any of its parts should not be repaired other than in accordance with written instructions provided by Datex-Ohmeda and by Datex-Ohmeda trained personnel. The product must not be altered without the prior written approval of Datex-Ohmeda's Quality Assurance Department. The user of this product shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, improper repair, damage, or alteration by anyone other than Datex-Ohmeda.

Sale restrictions

U.S. Federal and Canadian law restrict this device to sale by or on the order of a licensed medical practitioner. Outside the U.S.A. and Canada, check local laws for any restriction that may apply.

Responsibility of the manufacturer

The Datex-Ohmeda Division, Instrumentarium Corp. is responsible for the effects on safety, reliability and performance of the equipment only if:

- Properly trained and authorized personnel carry out assembly, operations, extensions, readjustments, modifications, periodical service or repairs.
- The electrical installation of the relevant room complies with the appropriate requirements.
- The equipment is used in accordance with this User's Reference Manual.
- Datex-Ohmeda assumes no responsibility for the use or reliability of its software on equipment not provided by Datex-Ohmeda.

General warnings and cautions

WARNING designates a possible dangerous situation. Non-observance may lead to death or injury.

CAUTION designates a possibly harmful situation. Non-observance may lead to damage to the product.

Hazards related to improper installation, use and service of the ADU

WARNING **The following precautions must be observed:**

- **The ADU is only to be operated by, or on the order of, a physician.**
- **The installation of the ADU is only to be done by trained service personnel.**
- **Service is only to be done by trained service personnel with proper tools and test equipment.**
- **Read the User's Reference Manual and the Technical Reference Manual before performing service to the ADU.**
- **Perform a Functional Check and Safety Test after any repair or calibration of the ADU.**
- **The manufacturer accepts no responsibility for any modifications of the ADU outside the factory.**
- **Do not connect external equipment or accessories to the ADU system other than those specified by Datex-Ohmeda.**
- **Do not perform any testing or maintenance while the ADU is connected to a patient.**

Electric shock hazards

WARNING **To avoid the risk of electric shock hazard the following precautions must be observed:**

- **Disconnect the electric power cord before cleaning or performing maintenance of the ADU**
- **Confirm that the ADU and AC-operated equipment used together with the ADU is properly grounded.**

- The connection of equipment to the auxiliary mains outlets may increase the patient leakage currents to values exceeding allowable limit.
- Do not autoclave any part of the ADU system except those specified in User´s Reference Manual through the use of steam or ethylene oxide.
- Do not allow liquid to enter the interior of the equipment.
- Do not touch any exposed wiring or conductive surface while the cover is off and the ADU energized. The voltages present may cause injury or death.
- The power cord and plug must be intact and undamaged.
- Do not remove the grounding pin from the power plug. Do not use extension cords or adapters of any type.
- Replace the power cord if its cracked, frayed, broken or otherwise damaged.
- To power the ADU, use only a hospital grade grounded electrical outlets and power cord. Adequate grounding can only be ensured if the equipment is connected to a receptacle marked "Hospital Grade".
- Make sure that any external equipment which is to be connected to Datex-Ohmeda equipment is hospital grade grounded.

Hazard related to explosion, fire or burns

WARNING To avoid the risk of explosion, fire, or burns the following precautions must be observed:

- Flammable anesthetic agents or gases such as ether and cyclopropane must not be used with the ADU. Only agents which comply with the requirements for non-flammable anesthetic agents according to IEC 60601-1 can be used.
- As this workstation is not to be used with flammable anesthetic agents or gases, the use of antistatic breathing tubes and face mask is not recommended. Burns may occur if antistatic or electrically-conductive breathing tubes are used while high-frequency electric surgery equipment is in use.
- High pressure or medical gases may cause explosion or burn strongly when reacting with organic material such as lubricants, paint, greasy fingerprints, dirt, dust fluff, and other organic waste.
- Do not use oil, grease, or silicone-based lubricants. Only PTFE-based, oxygen compatible lubricants are approved.
- There is always a risk wherever anesthethic agents are used and handled. Do not use the ADU in insufficiently ventilated areas, thus avoiding raised concentrations of anesthetic agents in operating rooms. Use gas scavenging at all times.

Other hazards

WARNING **A reconfiguration of user defaults must be done by a trained physician or by trained personnel on order of a physician.**

WARNING **PC boards out of order shall not be repaired by the user but by Datex-Ohmeda.**

WARNING **Never immerse vaporizers in any liquid.**

CAUTION Open the reserve gas cylinder valves (yokes) slowly to avoid harmful pressure shock.

CAUTION Use mild detergent solution to clean the unit. Do not use ammonia-, phenol-, or acetone-based cleaners as these cleaners may damage the surface of the ADU.

CAUTION Electrostatic discharge through PC boards may damage the components on them. Wear a static control wrist wrap before touching the PC boards.

CAUTION Handle all PC boards by their non-conductive edges and use anti-static containers when transporting them.

CAUTION Do not gas sterilize the ADU.

CAUTION Remove the battery fuses when the ADU is stored for a long time. This prevents the batteries from being discharged.

CAUTION Do not transport the ADU standing only on its castors, use original or equal transport package to avoid shock damages.

CAUTION The ADU must be stabilized at temperature specified in *“Technical specifications”* section before use.

Equipment classification

Classification according to IEC 60601-1

- Class I equipment according to the type of protection against electrical shock.
- Type B (Body) equipment according to the degree of protection against electrical shock.
- The equipment is not suitable for use in the presence of flammable anesthetic mixture with Air or with oxygen/nitrous oxide.
- Continuos operation according to the mode of operation.

Classification according to IEC 529

Degree of protection against the ingress of water as detailed in IEC 529: IPX1.

Classification according to the Council Directive 93/42/EEC (EU Medical Device Directive)

The ADU is CE-marked according to the Council Directive 93/42/EEC. The equipment is classified as II b.

Safety standards incorporated into the ADU

The ADU complies with the requirements standards following:

- General requirements for safety:
  International Standard IEC 60601-1:1988
- Particular requirements for the safety of anesthetic machines:
  International Standard IEC 60601-2-13:1989

The ADU complies to following standards with the below listed exceptions:

- Particular requirements for anesthetic workstations and their modules:
  European Standard EN 740:1998
- Inhalation Anesthesia Systems - Part 1
  Anesthesia workstations and their components, particular requirements. ISO/DIS 8835-1.

Exceptions:

- Cross connection of the manual and ventilation hoses is prevented by incompatible patient circuit and manual bag hose connectors (not by instruction labels).
- For each medical gas required by the ADU, the time weighted average over 10 s at steady state flow, shall not exceed 60 l/min. at a pressure of 280 kPa, measured at the gas inlet port. These gas flows may however be exceeded with an active scavenging ejector and extreme inspiratory flow settings.
- The differential pressure in the scavenging system is 29 cmH2O at 25 l/min.

Specifications for warning, cautionary, advisory and information signals used in Anesthesia and critical care medical equipment. European Standard EN475, International Standard ISO 9703-1 and -2.

- Units sold in Canada comply with CSA standards 601.1 and 601.2.13.

ADU safety features

The safety features listed below are incorporated in the Anesthesia Delivery Unit.

Gas supply	• O_2, N_2O and Air supply failure alarm • Overpressure regulation for wall outlets O_2, Air and N_2O at 9 bars
Gas mixer	• Electronic O_2/N_2O ratio control and N_2O cut-off • Automatic switching from N_2O to Air if N_2O pressure is lost

Vaporizer: Aladin Cassette

- Overfilling protection
- Protection against overdosing after tilting
- The Desflurane cassette is equipped with a special over-pressure relief valve.
- Automatic cassette identification
- Means to prevent delivery of more than one agent at a time
- Automatic vaporizer shut-off
- - in case fresh gas flow is lost
- - in case cassette is removed

Ventilator

- With loss of primary ventilator driving gas (Air or O_2) automatic switch to the secondary driving gas. (O_2 or Air)
- Visible rising bellows allows fast and easy leakage detection
- Adjustable maximum pressure release in Auto mode (mechanical ventilation), Pmax Release with automatic switch to expiration
- Overpressure release valve in fresh gas outlet at 80 cmH_2O
- Single switch operation of the ventilator
- High pressure alarm in the breathing system
- Low pressure alarm in the breathing system
- APL valve in the manual breathing circuit

Datex-Ohmeda compact patient circuit (optional)

- Absorber locking mechanism allows easy canister/absorber replacement during operation.
- Clearly visible absorber canister and one-way valves

Other safety features

- Mains power failure alarm
- Full battery back up for 20 minutes.
- Optional extra gas cylinders

3 SYSTEM DESCRIPTION

Please read the *“User’s Reference Manual”* to obtain a clear understanding of the Anesthesia Delivery Unit.

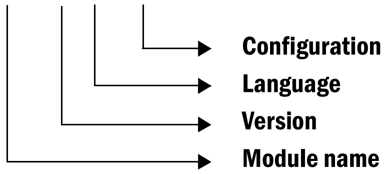
The ADU is built up in a modular way. There are seven main sub-modules (Units). The main sub-modules are:

- A-AUF = Anesthesia Unit Frame. (Carries the ID No. of the unit)
- A-ELEC = Central Electronics Unit.
- A-FGC1 = Fresh Gas Control Unit.
- A-WGU = Wall Gas Unit
- A- EV1 = Electronic Ventilator Unit.
- A-BB = Bellows Block Unit.
- D-LCCADU = LCD Display ADU

Some of the modules have a Device Plate, which indicates the module name, version, language and configuration.

For example:

A-WGU..00.EN..AEE



Front view of the ADU

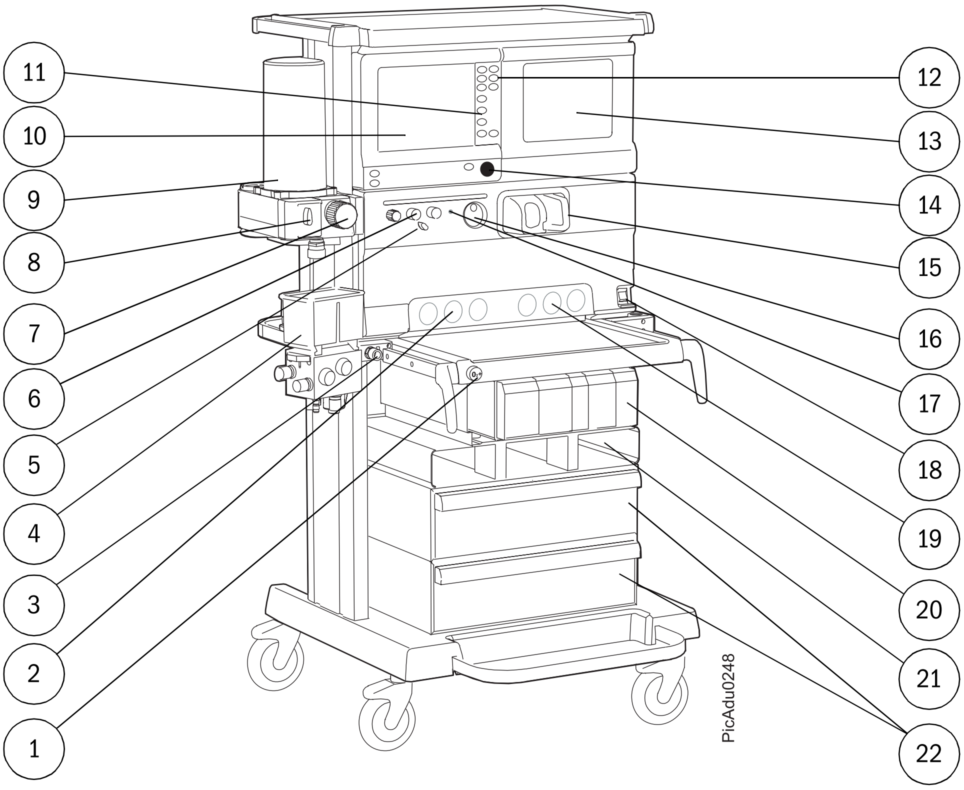


Figure 1 **Front view of the ADU**

(1)	O_2 flush control	(13)	Anesthesia Monitor 10” LCD color display
(2)	Pipline gas inlets’ pressure gauges	(14)	ComWheel
(3)	Fresh gas outlet	(15)	Aladin, vaporizer cassette
(4)	Compact patient circuit	(16)	Anesthetic agent concentration control
(5)	N_2O/Air selector	(17)	Vaporizer ”On” indicator lamp
(6)	Fresh gas flow controls	(18)	On /Standby switch
(7)	Adjustable pressure limiting valve (APL)	(19)	Optional cylinder pressure gauges
(8)	Auto/Manual ventilation mode selector	(20)	Anesthetic Monitor central unit & modules (option)
(9)	Ventilator Bellows Block with bottle	(21)	Vaporizer cassette storage slots (optional)
(10)	ADU 10” LCD color display	(22)	Optional drawers
(11)	Ventilator ”Quick” function keys		
(12)	Alarms, Setup, Trends etc. keys		

Rear view of the ADU

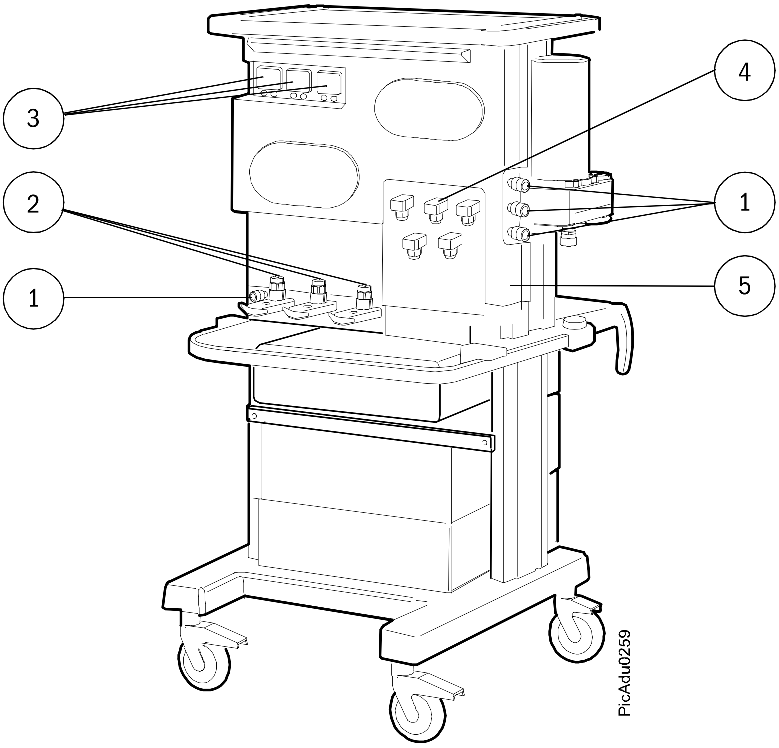


Figure 2 **Rear view of the ADU**

(1) Auxiliary Air/O_2/vacuumoutlets (optional)

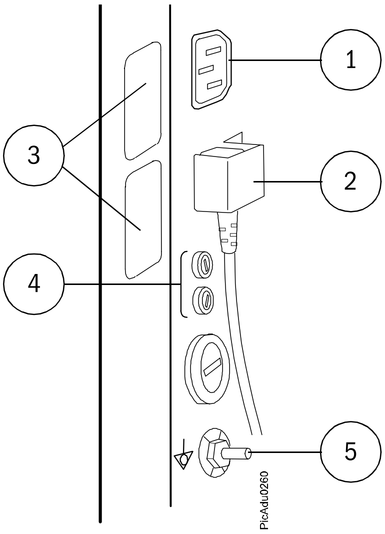
(2) Cylinder yokes (optional)

(3) Auxiliary mains supply outlets (optional)

(4) Gas supply and scavenging connectors

(5) Scavenging ejector with flow indicator or scavenging flow indicator (optional)

Rear panel functions



(1) Mains outlet for Anesthesia Monitor

(2) ADU mains power cord
(or connection cord for box of Auxiliary Mains Outlets).

(3) Product labels.
Contains information on type of device, Identification No., year of manufacture and electrical requirements.

(4) Mains fuses
(For service purposes only)

(5) Potential Equalization Terminal

Auxiliary mains outlets and gas supply inlets

The three auxiliary mains outlets are reserved for monitors and other electrical devices mounted on the ADU.

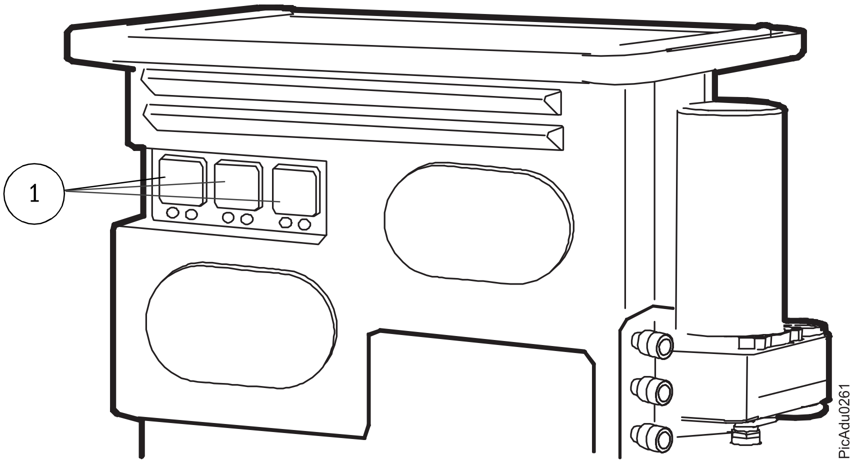


Figure 3 **Auxiliary mains outlets (1)**

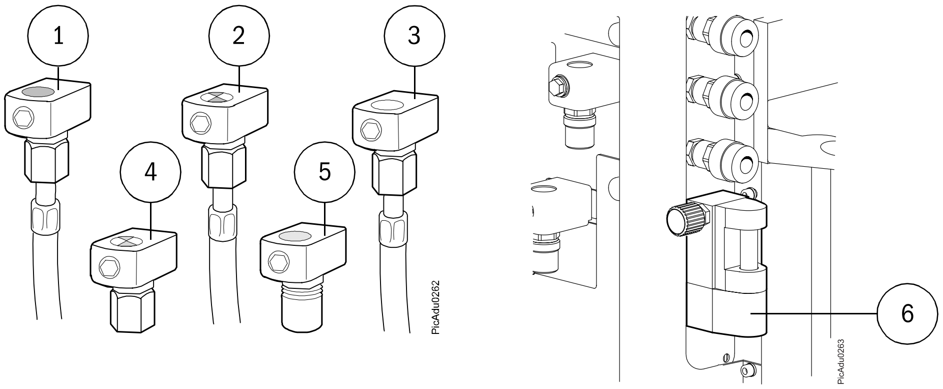


Figure 4 **Gas supply inlets (to the left) and scavenging ejector (to the right)**

(1) Nitrous oxide inlet
(2) Air inlet
(3) Oxygen inlet
(4) Gas scavenging outlet (EVAC)
(5) Vacuum outlet (optional)
(6) Built-in scavenging ejector with indicator. Max. flow is achieved by adjusting the flow ejector knob according to the indicator response.

Each connector is designed to be coupled to its corresponding hose. The connectors and hoses are color coded.

Functional units

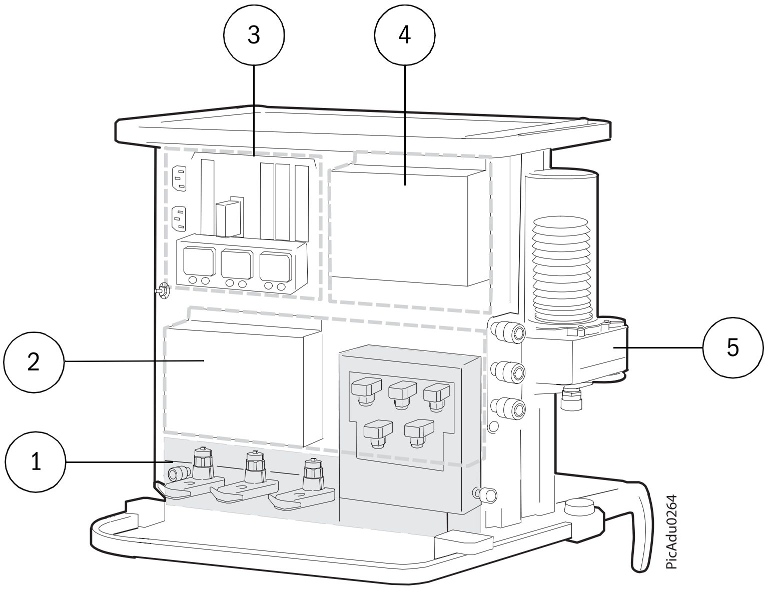


Figure 5 Functional units

(1) Wall Gas Unit, A-WGU
(2) Fresh Gas Control Unit, A-FGC1
(3) Central Electronics, A-ELEC
(4) Electronic Ventilator, A-EV1
(5) Bellows Block, A-BB

Ventilator with compact patient circuit

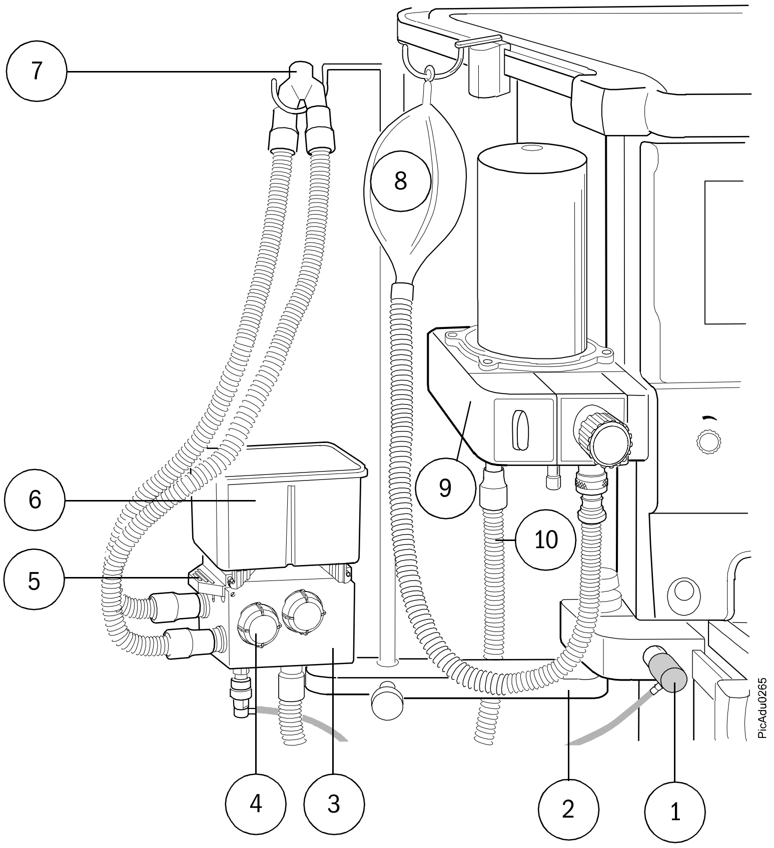


Figure 6 **Compact patient circuit**

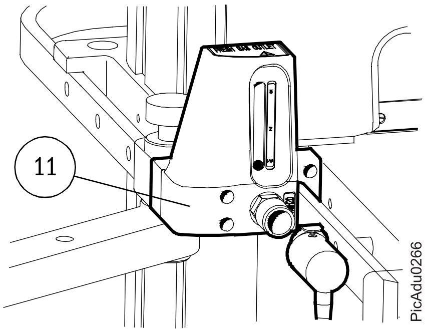


Figure 7 **Fresh gas flow indicator**

(1) Fresh gas supply connection (Common gas outlet)
(2) Circuit boom
(3) Compact block
(4) Valves for inspiration and expiration
(5) Locking/releasing ledge for absorber canister
(6) Absorber canister
(7) Inspiration and expiration hoses with Y-piece
(8) Manual ventilation bag with hose
(9) Bellows block
(10) Ventilation hose
(11) Fresh gas flow indicator (optional)

Compact Block

Gas flow within the Compact Block and the single use absorber.

Pictures below shows the principles of the gas flow through compact block. There are two models of compact blocks and the pictures below illustrate a compact block ACC1.

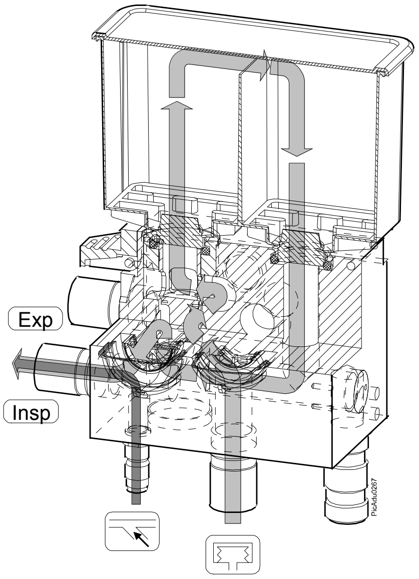

Exp
Insp
PicAdu0267

Figure 8 **Inspiratory flow**

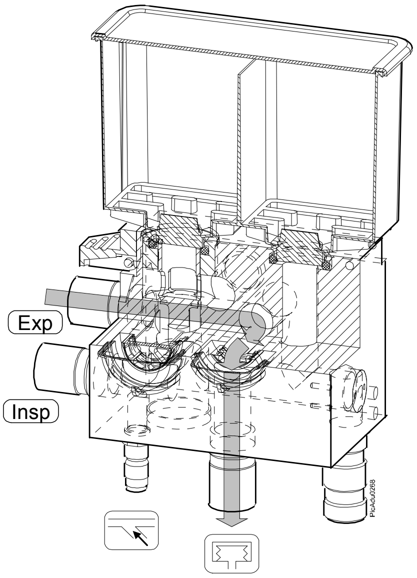

Exp
Insp
PicAdu0268

Figure 9 **Expiratory flow**

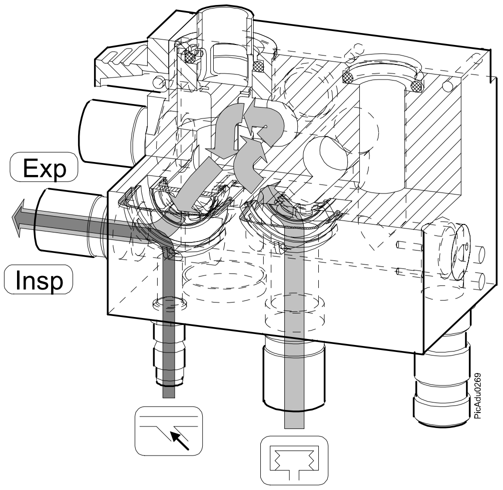

Exp
Insp
PicAdu0269

Figure 10 **Inspiratory flow without absorber**

	Fresh gas flow inlet	Exp	Expiration connector
	Bellows connection	Insp	Inspriation connector

Frame Pneumatics (A-AUF)

Functional description

The wall gas unit is in the Frame, and offers all customer specific pneumatic connections: gas inlets for O_2, Air and N_2O / connections for extra gas bottles / vacuum (VAC) / evacuation (EVAC) / pressure gauges for central and bottle supply pressures. The gas inlets are intended for connection to the central gas supply of the hospital.

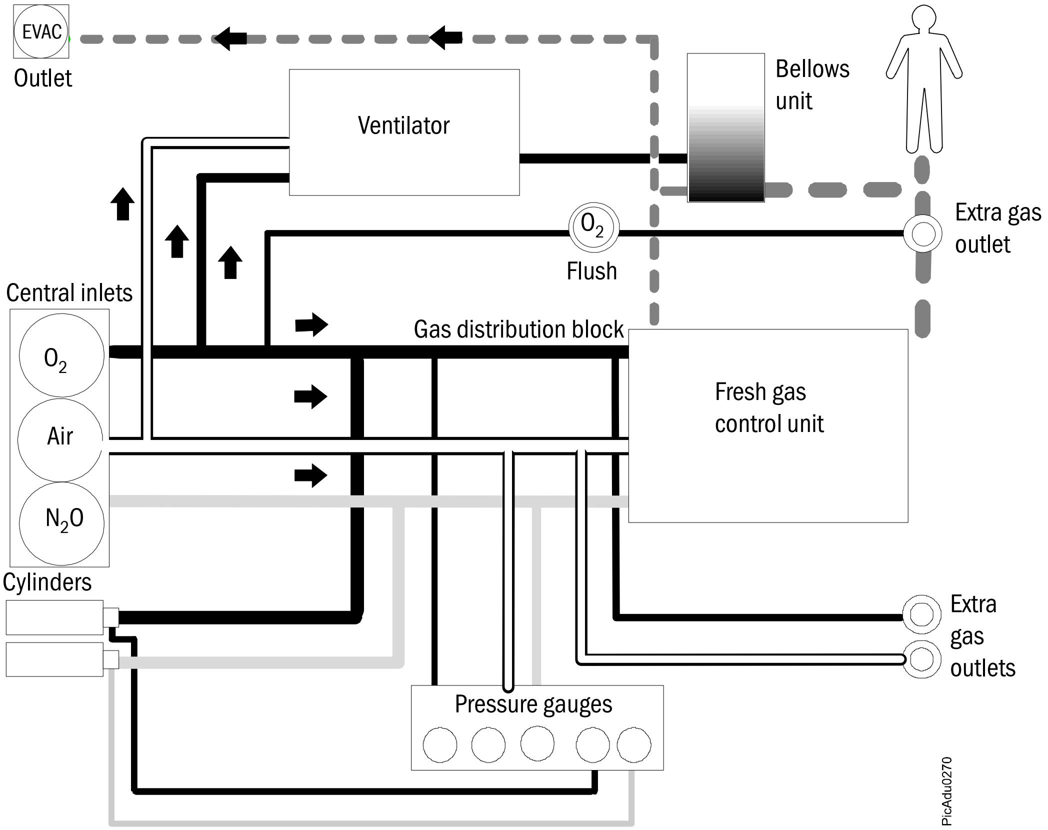
On the rear of the wall gas unit there are optional cylinder connections for O_2 and N_2O reserve gas cylinders. If there is a loss of wall supply pressure, the user may turn on the reserve gas cylinder. When the hospital central gas system supplies the gas, the reserve gas cylinders must be off.

The gases from the gas inlets or reserve gas cylinders are distributed within the wall gas unit to the pressure gauges, O_2 flush regulator and O_2 flush valve.

The supply gases are further distributed through the wall gas unit to the Ventilator and fresh gas control unit via pneumatic connections. One connecting supplies gases Air, O_2 and N_2O to the Fresh gas control unit, the other connecting supplies gases Air and O_2 to the Ventilator.

When the O_2 flush button is pushed, O_2 is flushed into the fresh gas outlet to which the patient system is connected. Adjustment of the O_2 flush flow is done with the O_2 flush regulator inside the wall gas unit.

If the O_2 supply pressure decreases to below 270 kPa (270-230 kPa) an electronic Low O_2 Supply alarm is visually and audibly activated. The pressure sensor for this alarm is in the Ventilator module.


EVAC
Outlet
Ventilator
Bellows unit
Extra gas outlet
O2
Flush
Central inlets
O2
Air
N2O
Gas distribution block
Fresh gas control unit
Cylinders
Extra gas outlets
Pressure gauges
PicAdu0270

Fresh Gas Control Unit (A-FGC1)

The wall gas unit is connected to the gas inlets of the fresh gas control unit inside the gas distribution block. The fresh gas control unit includes the flow controls and the vaporizer gas flow circuit.

Flow controls

The O_2, N_2O and Air flows are adjusted by means of mechanical needle valves.

The N_2O flow may be adjusted up to 75% of total flow. This assures a minimum of 25% O_2. Air may be adjusted independently of O_2 flow.

Flow transducers electronically measure the O_2, N_2O and Air flows.

With the N_2O/Air switch, the user may select either N_2O or Air to be mixed with O_2.

The mixed gas from the flow controls flows to the vaporizer gas flow circuit.

Electronically controlled vaporizer

The ADU is equipped with an electronically controlled vaporizer. The vaporizer gas flow circuitry and agent concentration control system has been integrated within the delivery unit.

The gas flow from the flow controls is divided into bypass flow and liquid chamber flow. The gas concentration is, through the control system, adjusted by changing the ratio between these two flows.

Aladin Cassette

The liquid chamber flow goes into the Aladin Cassette. This cassette is the only agent specific part of the vaporizer. The agent cassette contains liquid agent, which is vaporized when the gas flow passes through the cassette. The liquid chamber flow is then mixed with the bypass flow and conducted to the fresh gas outlet.

There are keyed systems for filling the cassette with anesthetic agent. A level window indicates the amount of liquid in the cassette. Changing the cassette, simply by pulling it out and inserting another one, changes the agent.

Electronic Ventilator (A-EV1)

The ventilator consists of a control unit and a bellows unit.

The user may select the patient ventilation from two different modes of operation: Auto or Manual. The selection is made by turning the Auto/Man. switch.

Auto mode

In Auto mode, driving pressure from the ventilator control unit, drives the bellows which ventilates the patient via the patient circuit. It is possible to run the electronic ventilator in three ventilation modes:

VCV: Volume Controlled Ventilation

SIMV: Synchronized Intermittent Mandatory Ventilation

PCV: Pressure Controlled Ventilation

There are two sources of driving gas, primary (Air/O_2) and secondary (O_2/Air). If the pressure of the primary gas is lower than 250 kPa (2.5 bar), the driving gas selecting unit automatically selects the secondary gas for driving the ventilator.

Manual mode

In Manual mode the user manually ventilates the patient with a bag.

The user adjusts the patient circuit pressure with the APL valve (Adjustable Pressure Limiting valve) next to the Auto/Man. switch.

When the APL valve is closed, the patient circuit pressure is approximately 80 cmH_2O. When the valve is opened, the patient circuit pressure is approximately 1,5 cmH_2O.

Patient breathing systems

The ADU accepts all commonly used breathing systems adapted to an ISO 15/22 mm outlet. There are two different semi-closed patient breathing circuit systems provided by Datex-Ohmeda: The Datex-Ohmeda Compact Patient Circuit and the Datex-Ohmeda Standard Patient Circuit.

The Datex-Ohmeda Compact Patient Circuit contains a switching mechanism which automatically diverts the gas flow through a bypass channel as soon as the disposable CO_2 absorber is removed. The disposable CO_2 absorber may be changed during Auto ventilation without causing a circuit leak.

The Datex-Ohmeda Standard Patient Circuit has a large absorber which contains 900 g soda lime. The CO_2 absorbent may be changed during Auto ventilation without causing a leak.

Scavenging

Waste gas flows through the over flow valve to the scavenging system inside the delivery unit.

If the hospital has an active central anesthesia gas scavenging system, the scavenging hose from the EVAC outlet should be connected to the central scavenging system.

If the hospital has a ”passive” central anesthesia gas scavenging system, the ADU must have been equipped with an additional scavenging ejector at the factory. The ejector is internally driven by Air. The waste gas is internally directed to the EVAC outlet. The EVAC outlet is then connected to the central scavenging system.

Central Electronics (A-ELEC)

The ADU is connected to the mains via a locked appliance inlet.

There are auxiliary mains outlets for connection of external equipment and a power cord for Anesthesia Monitor.

The power supply of the delivery unit transforms the mains AC voltage into a lower DC voltage. The internal power supply unit distributes power for all electronic components via a power bus (VBUS).

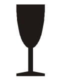
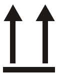
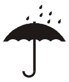
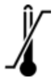
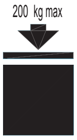
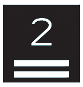
The digital section of the central electronics processes the information from ventilator, fresh gas control unit as well as keyboard, and feeds information to the LCD display. If a monitor is connected, the digital section functions as an interface between the monitor and the LCD display.

The flat screen display with keyboard consists of a separate power supply unit and an 8-color LCD display with backlight and keypad. An audio amplifier circuit amplifies alarm signals.

The central electronics unit communicates with the other electronic parts of the ADU via a serial communication interface.

Symbols

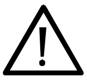
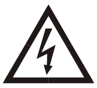
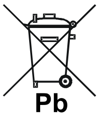
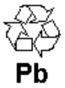
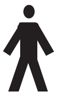
Symbols and text on transport packages

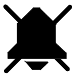
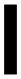
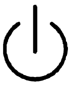
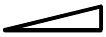
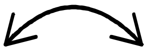
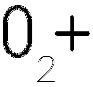
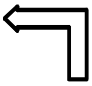
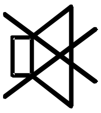
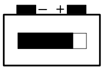
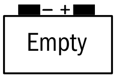
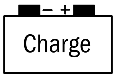
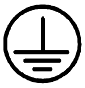
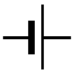
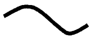
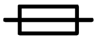
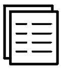
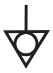
	The contents of the package are fragile and must be handled with care.
	Indicates the correct upright position of the transport package.
	The transport package must be kept in a dry environment.
	Indicates the temperature limitations within which the transport package should be kept and handled.
	Max load on top of the box.
	Maximum one placed upon another.

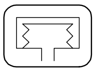
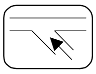
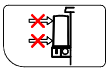
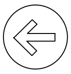
NOTE!
Do not lift from this side

Lift from this side
(Heavy side)

Symbols on equipment

	Attention! Please consult the accompanying documents.
	Dangerous voltage.
	This battery contains lead acid (Pb) and in case of disposal it must be separated from other waste according to local regulations.
	This battery contains lead (Pb) and may be recycled.
	Type B (Body) protection against electrical shock (IEC 60601-1)
IPX1	Degree of protection provided by enclosure (IEC 529)

	Silence alarm indicator
	Power on
	Stand by
	Variability
	Rotation in two directions
	O_2 flush
	Flow directions
	• Silence alarm • Alarm silenced for a given time • All alarm silenced
	Remaining battery capacity
	Battery empty
	Battery charging
	Protective earth
	Battery
	Alternating current
	Fuse
SN, S/N	Serial number
	Sub menu, Choosing an alternative with this symbol in a menu opens a new menu
	Potential equalizer

	Fresh gas flow inlet
	Bellows connection
	Do not expose the bellows chamber to side force. Keep free from gas cylinders, cables etc. Side force or impact on the chamber may create a leak in the ventilator bellows drive circuit.
	Gas flow direction
	Single use
Exp	Expiration connector
Insp	Inspiration connector

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4 INSTALLATION INSTRUCTIONS

WARNING **The installation of the ADU must be done by properly trained and authorized technical personnel.**

Introduction and requirements

The ADU is manufactured according to your order.

The ADU must be connected to mains electrical power and gas supplies as specified in the *"Technical Specifications"* section.

The installation of the ADU must be done by properly trained and authorized technical personnel according to these instructions. Use the *"Installation Check List*" as a guide to ensure all steps are completed. The list is located in the *"Forms"* section.

The installation steps are:

1. Setting up the unit
2. Connecting the monitors
3. Configuring the software
4. Performing the functional check

How to use these installation instructions

These instructions provide the information needed to set up the Anesthesia Delivery Unit after unpacking. They also state the basic information on configuring user default settings and interfacing other equipment.

For information on how to use, clean and check the unit, or how to connect the patient circuits, please refer to the User's Reference Manual provided.

NOTE: The frame options and products specific to the ADU, are all listed in the ADU System Guide. Please check the System Guide for relevant order codes and compatibilities.

Setting up the ADU

Unpack the unit according to the *"Open me first"* instructions located in the delivery package. The *"Open me first"* package includes unpacking instructions and the *"ADU Production Card"*, which must be saved in your device history records. The Production Card includes for example, all the necessary order, version and serial number information. Check that the unit corresponds with the original order.

If the ADU temperature is outside the specified operating temperatures, the unit must be warmed up or cooled down to normal operating temperature before use. For example , the unit requires 2 hours typically, to warm up from 0 °C to 20 °C. The unit may be moved on its four castors (wheels) to be placed in an optimal position. The front castors may be locked.

The ADU is delivered without the local of type of connectors for the gas hoses. The connectors must be attached to the hoses with a crimping tool.

Connections of the anesthesia delivery unit.

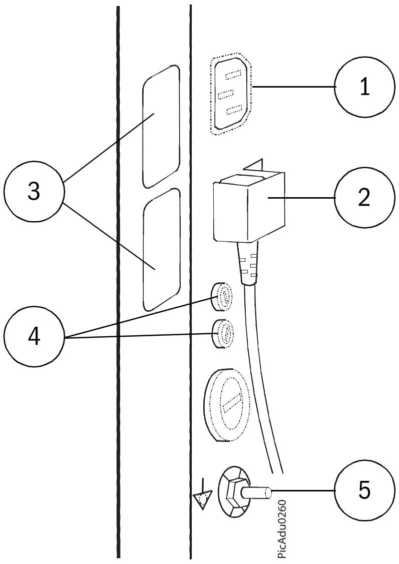


Figure 1 **Rear connection panel**

(1) Mains connector for Anesthesia Monitor or Capnomac Ultima.

(2) ADU mains power cord (or connection cord for Auxiliary Electrical Outlets).

(3) Product ID labels. Contains information on type of device, identification number, year of manufacture and electrical requirements.

(4) Mains fuses (For service purposes only).

(5) Potential Equalization Terminal

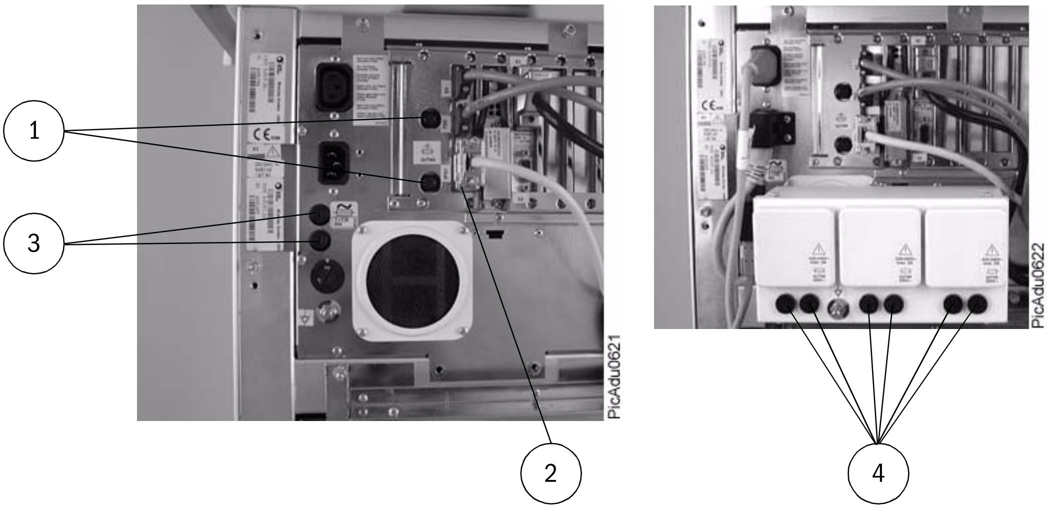


Figure 2 **Fuses and serial connector**

(1) Battery fuses

(2) Serial connector for monitors

(3) Mains fuses

(4) Auxiliary electrical outlet fuses

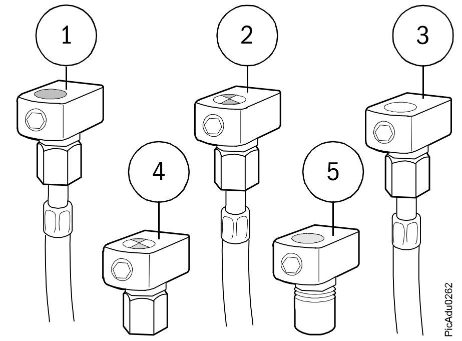

1
2
3
4
5
PicAdu0262

Figure 3 **Gas supply inlets**

(1) Nitrous oxide inlet

(2) Air inlet

(3) Oxygen inlet

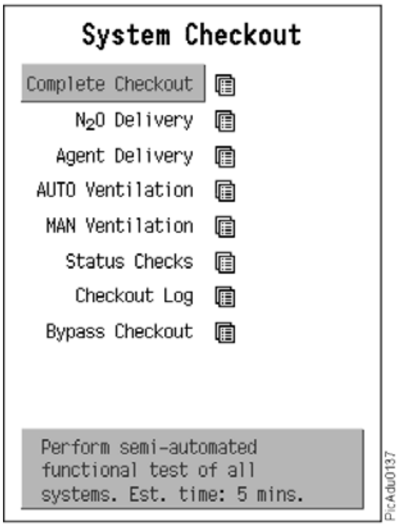
(4) Gas scavenging outlet (EVAC)

(5) Vacuum inlet (optional)

Each connector is designed to be coupled with its corresponding hose. The connectors and hoses are color coded.

Power cord

- Check the power cord for damage. Connect it to the ADU and ensure that the plug fits the local mains power outlets. Replace it if necessary.
- Connect the power cord to the mains power supply outlet and check that the green LED close to the On/Standby switch is lit. Switch on the ADU and check that a beep sounds after a short while. The software revision number should appear on the display. The display should then switch to the Normal Screen showing the System Checkout menu.


System Checkout
Complete Checkout
N_2O Delivery
Agent Delivery
AUTO Ventilation
MAN Ventilation
Status Checks
Checkout Log
Bypass Checkout
PicAdu0137

Perform semi-automated functional test of all systems. Est. time: 5 mins.

Figure 4 **System Checkout Menu**

Batteries

CAUTION If the batteries become discharged they will be damaged. Even if the ADU not is being used the batteries will slowly be discharged.

NOTE: If the ADU is stored more than two months it is recommended to connect the ADU to mains and let the batteries be fully charged. An alternative method is to temporarily remove the fuses from the battery charger board.

1. Disconnect the power cord from the mains power supply outlet and check that the ADU is running on battery power. Check that a battery symbol with a green bar appears in the upper right corner of the screen. (The green bar indicates the remaining battery capacity).
2. If the batteries are discharged, they should be charged for at least 4 hours by keeping the power cord connected to the mains outlet. The ‘Charge’ battery symbol should then disappear from the message screen.
3. The batteries are always being recharged when the mains plug is connected and the green light is lit on front panel.

Central gas supply hoses

1. Check that the central gas supply hoses (O_2, Air and N_2O) are in good condition.
2. Check that the connectors are suitable for hospital pipeline gas outlets or pendulum gas outlets.
3. Connect the hoses to the hospital pipeline gas outlets.
4. Check that the front panel gas pressure gauges show the correct inlet pressures (2,7 - 8,0 x 100 kPa (39.16 - 116.0 PSI))

Scavenging

When a patient system that returns gas to the bellows block is used, the excess gas flows through the overflow or the APL valve to the scavenging system inside the ADU.

Central active high/low vacuum scavenging system

If the hospital has a high vacuum scavenging system— which has a minimum vacuum of -300 mmHg (-12 in Hg)— requiring a choke orifice gas connector, or if the hospital has a low vacuum scavenging system:

1. Connect the scavenging hose from the EVAC outlet on the ADU to the central system.
2. Check that the scavenging flow indicator is in operation.

Central Passive scavenging system

If a hospital has a passive scavenging system, the A-SEJ2 option is required. This is an internal scavenging ejector that is built into the ADU.

The optional scavenging ejector with a flow adjusting control, is attached to the wall gas unit module (see picture below). The ejector takes its driving gas from the central air supply and the waste gas is internally directed to the EVAC outlet.

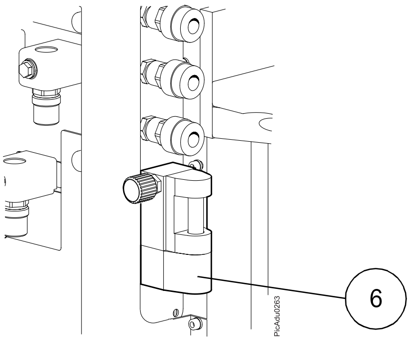


Figure 5 A-SEJ2 With flow indicator

1. Adjust the scavenging flow with its control. Check that the waste gas flows through the EVAC outlet.
2. Connect the scavenging hose from the EVAC outlet to the central scavenging system of the hospital.
3. Check and adjust the scavenging flow to desired value i.e. the ball in the flow tube should float up to the middle position to be sure that a minimum scavenging flow of 25 l/min. is achieved.

Vacuum (optional)

Connect the vacuum hose from the rear panel of the unit to the central vacuum network of the hospital.

Reserve gas cylinders (optional)

1. Connect the reserve gas cylinders to the yokes on the back of the ADU. The yokes have gas specific connector coding to prevent incorrect connections.
2. Open the cylinders slowly and check that the cylinder pressure gauges on the front panel are functioning.
3. Close the cylinders after checking the pressures.

NOTE: When not in use, always keep the cylinders closed. The reserve gas cylinders must only be used when the central gas supply is lost.

Fresh gas outlet

A 15/22 mm fresh gas outlet is located on the left front corner of the ADU.

Connect the fresh gas hose between the fresh gas outlet and the patient circuit. See the "*User's Reference Manual"* for connection of various patient circuits.

Fresh Gas Flow Indicator A-FGFI (optional)

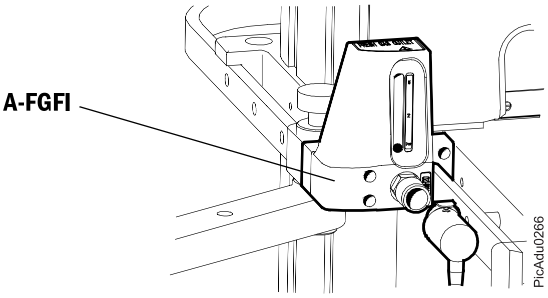


Figure 6

Check that indicated flow is approximately the same as set fresh gas flow.

Auxiliary quick gas connectors (optional)

Extra gas outlets (female) are located on the left-hand side panel of the unit. The gas delivered through these connectors is supplied by the central gas system or the reserve gas cylinders. These outlets are intended for extra gas distribution to separate medical devices or for example, the connection of a suction unit for the extra vacuum outlet connector.

NOTE: There may be an optional air or vacuum connector on the back right-hand side of the unit. This means that there could be two air connectors, one on the front left side and one on the right back side of the unit.

Auxiliary mains outlets (optional)

On the back panel there are three auxiliary mains outlets including fuses. Only electrical equipment approved for medical use should be connected to these outlets.

Power to the auxiliary mains outlets is on whenever the power cord of the ADU is connected.

Installation of monitors

The Anesthesia Delivery Unit can be interfaced with the Anesthesia Monitor or the Capnomac Ultima by means of a serial interface connection. Which parameters and other items to transfer the delivery unit depend on the monitor type. The transferred information includes numeric as well as waveform data. Suitable software versions are stated in the "*Transference of Parameters*" paragraph.

Prerequisites

Serial interface connector

Use only official Datex-Ohmeda monitor cables for the Anesthesia Monitor and Capnomac Ultima.

Serial connector (X1) configuration

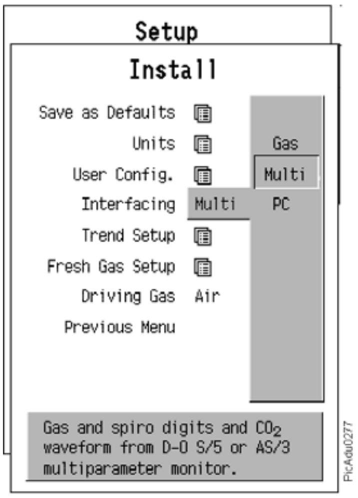
The connector is located on the Digipower board of the Central Electronics unit.

9-pin female D-connector configuration

Pin	Signal
1	N.C.
2	RxD RS232
3	TxD RS232
4	Analogue input
5	Ground
6	N.C.
7	RTS RS232
8	CTS RS232
9	ADU ON

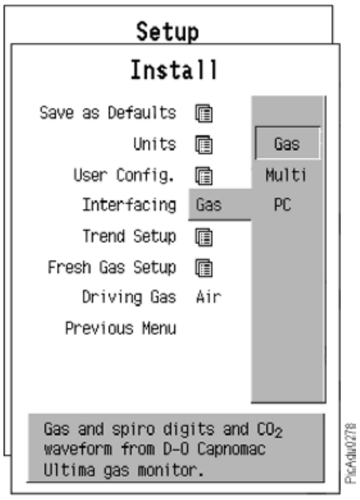
The following Interfacing setting defaults may be configured on the ***Install*** menu:

- Gas
- Multi
- None / PC


Setup
Install
Save as Defaults
Units
User Config.
Interfacing
Multi
Trend Setup
Fresh Gas Setup
Driving Gas
Air
Previous Menu
Gas
Multi
PC
PicAdu0277

Gas and spiro digits and CO_2 waveform from D-O S/5 or AS/3 multiparameter monitor.

Figure 7 **Text displayed in *ThermoScroll* menu: *Gas*, *Multi* and *None*. When *Multi* is selected the Prompt text will be: 'Gas and spiro digits and CO_2 waveform from D-O S/5 or AS/3 multi parameter monitor.'**


Setup
Install
Save as Defaults
Units
User Config.
Interfacing
Gas
Trend Setup
Fresh Gas Setup
Driving Gas
Air
Previous Menu
Gas
Multi
PC
PicAdu0278

Gas and spiro digits and CO_2 waveform from D-O Capnomac Ultima gas monitor.

Figure 8 **Text displayed in *Thermoscroll* menu: *Gas*, *Multi* and *None*. When *Gas* is selected Prompt text will be: 'Gas and spiro digits and CO_2 waveform from D-O Capnomac Ultima gas monitor.'**

After connection of a monitor, select the corresponding interface selection from the Install menu.

The Anesthesia Monitor central unit

Check the monitor interface products in the *"ADU System Guide"*.

1. Turn off the ADU and the monitor.
2. Remove the back panel and any options, such as Aladin slots, to get access to the monitor frame rack and serial interface connections.
3. Adjust the monitor frame rack in the ADU to the corresponding monitor central unit configuration. The three available positions are Central Unit FCU8 only, FCU8 with Airway Module or FCU8 with Extension Frame.

4. Install the Central Unit of the monitor into the monitor frame rack. Fasten the two screws holding the central unit and monitor frame rack together.
5. Connect the Serial Connector of the ADU to the Serial Interface connector of the UPI board in the monitor with the ADU Monitor Cable. Tighten the screws.
6. Connect the Anesthesia Monitor power cord to the reserved mains connector in the ADU.
7. Install the monitor display.
8. Turn on the ADU and the monitor.
9. Reinstall panels and other options.
10. Select ***Multi*** on the interfacing selection field of the ***Install*** menu.
11. Check that the integrated parameters are transferred to the middle field of the screen when both the ADU and monitor are running.

Anesthesia Monitor Video Display 14'' (D-VHC14)

1. Place the video display on the top shelf.
2. Secure the video display to the top shelf.
3. Connect the power cord of the video display to the power outlet of the Anesthesia Monitor Central Unit.

See the Installation Instructions for the Anesthesia Monitor on how to connect the display to the Central Unit of the monitor.

Anesthesia Monitor Video Display 15'' (D-VNC15)

1. Place the video display on the top shelf.
2. Secure the video display to the top shelf.
3. Connect the power cord of the video display to the power outlet of the Anesthesia Monitor Central Unit.

See the Installation Instructions for the Anesthesia Monitor on how to connect the display to the Central Unit of the monitor.

Anesthesia Monitor LCD Display (D-LCC10W and D-LCC15W)

The Anesthesia Monitor LCD Display may be placed on the ADU front panel, next to ADU's own display, or use the Display Arm to position the LCD display closer to the patient. See the *"ADU System Guide"*.

Attaching the LCD display to the front panel

Tools:	*Pozidriv screwdrivers* *Allen keys*
Parts:	*LCD Display, D-LCC10W* *includes the LCD Display Cable, 2,5 m 888525* *includes the LCD Display - ADU Mount kit 889151*

NOTE: If previous versions of LCD displays, D-LCC10 rev. 03 or 04 are installed, the display cable and mounting kit must be ordered separately. Check the revision of your display on the device label.

1. Turn off the ADU and disconnect the power cord from the power outlet.
2. Remove the top shelf by removing the top screws.
3. Remove the right side blank panel in front of the ADU and the back panel.

4. Draw the display cable through the ADU and connect it to the monitor.
5. Connect the cable from the back of the monitor LCD display with two screws to the frame of the ADU.
6. Reinstall the top shelf and back panels.

Capnomac Ultima

1. Turn off the ADU and the monitor.
2. Place the Capnomac Ultima on the top shelf.
3. Connect the Serial Connector of the delivery unit to the Serial & Analog connector of the Ultima with the ADU - Capnomac Ultima Cable.
4. Connect the power cord of the Ultima to one of the three auxiliary power outlets at the back of the ADU.
5. Turn on the unit and the monitor.
6. Select ***Gas*** on the interfacing selection field of the Install menu.
7. Check that the integrated parameters are transferred to the middle field of the screen when both the ADU and the monitor are running.

Transference of parameters

Check that the following parameters appear on the ADU display screen when gently breathing into the monitor's gas sampling line. If the CO_2 waveform is configured, the waveform and digital values should appear on the ADU display screen.

Capnomac Ultima to the ADU

Waveforms	**Numerics**
CO_2	Et & Fi CO_2%; Et & Fi O_2%; O_2% Difference (I-E) Et & Fi N_2O%; Et & Fi AA%; Vol. Exp MV; Vol. Exp TV

NOTE: The Capnomac Ultima must be equipped with 882916 - 3.0 (English), 882917 - 3.0 (German), 884234 - 2.0 (French) or later software.

Anesthesia Monitor to the ADU

Waveforms	**Numerics**
CO_2	Et & Fi CO_2%; Et & Fi O_2%; O_2% Difference (I-E) Et & Fi N_2O%; Et & Fi AA%; Vol. Exp MV; Vol. Exp TV

NOTE: The Anesthesia Monitor must be equipped with S-STD94 or later software.

ADU to the Anesthesia Monitor with record keeper

The following parameters are transferred from the ADU to the record keeper.

Events transferred once a minute	
Ventilator settings	Ventilation (mode); Tidal Volume; Minute Volume;Resp. Rate I:E Ratio; I:E Times: insp; I:E Times: exp; Insp. Pause

Events transferred once a minute	
Ventilator measurements	Ppeak; Pplat; Peep; Pmin
Fresh gas settings	Agent name; Agent % in fresh gas; Total flow O_2 flow; N_2O flow; Air flow

Events transferred during system check	
System check test results	Gas Delivery: Agent; Gas Delivery: N_2O; Leak Tests: AUTO AUTO leak [ml/min]; Leak Tests: MAN; MAN Leak [ml/min] Number of confirmed checklist items; Bypass Check

NOTE: The Anesthesia Monitor must be equipped with S-ARK95 or later software.

Configuring the software

Configuration requirements

The Anesthesia Delivery Unit is already factory configured in order to comply with national standards and most common practices. The unit may be operated without changing these screen default settings.

Datex-Ohmeda has designed the ADU so that the default settings may be changed to meet hospital standards. Once changed and saved, the defaults will become active whenever the unit is turned on. The factory defaults may always be reset if needed.

WARNING **If the factory defaults values are reset, the flow bars order on the display will be set-up to ISO standard.**

If the factory defaults values are reset, the flow bars order on the display will be set to ISO standard, i.e. that the flow bars order starting from the left side are *O_2 - Air - N_2O*. This means that countries using ANSI standard must change the flow bar order starting from the left side on the display to *N_2O - Air - O_2*. This is done by entering the ***Install*** menu (distributor password level is required)**- *Fresh Gas Setup*** and make necessary configuration changes. The colors of the bars will not be changed if the factory defaults are reset.

NOTE: All the default changes should be performed first and then saved, all at the same time, by using the Install menu. See "*Saving the Configuration*" at the end of this section.

Always use the default configuration worksheet during a user default configuration and save a copy of the sheet in the device history records.

System configuration

Check the following items and change configuration if required:

- ***Ambient pressure*** on the ***Install - User config*** menu.
- Primary driving gas for the Ventilator (O_2 or air) on the ***Install*** menu.

If the factory default settings are changed for these functions, they cannot be reset by the factory defaults function. Resetting must be done manually.

Country specific requirements

In some countries law requires the following software configuration alternatives. They are however available to all users.

”French and U.S. version” (Compulsory in France and the U.S.)

User alarm ‘*Volume monitor removed*’ is displayed if no volume monitor is connected or it is switched off.

On the ***Install - User Config*** menu, set to ***Yes***. (Default setting is ***No***).

”Japanese version” (Compulsory in Japan)

User alarm *‘Agent % setting high*’ is displayed if sevoflurane anesthetic agent is set above 5%.

On the ***Install -User Config*** menu, set to ***Yes***. (Default setting is ***No***).

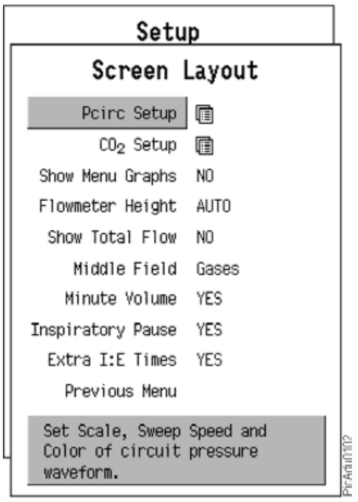
If the factory default settings are changed for these functions, they cannot be reset by the factory defaults function. Resetting must be done manually.

User defaults configuration

WARNING **A reconfiguration of the user defaults must be done by a trained physician or by trained personnel on order of a physician.**

The following ***Screen Layout*** defaults may be configured:

- Waveform fields
- Fresh gas field
- Ventilator field
- Middle field
- Optional field



Setup

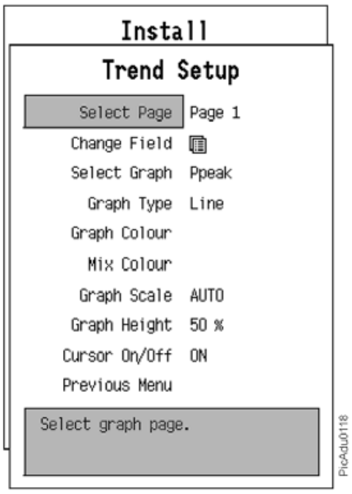
Screen Layout

Pcirc Setup ▤
CO_2 Setup ▤
Show Menu Graphs NO
Flowmeter Height AUTO
Show Total Flow NO
Middle Field Gases
Minute Volume YES
Inspiratory Pause YES
Extra I:E Times YES
Previous Menu

Set Scale, Sweep Speed and Color of circuit pressure waveform.

The following ***Trend*** setting defaults may be configured:

- Trend fields and pages
- Numerical or graphical trends
- Trend scales
- Color and type of Graphical trends



Install

Trend Setup

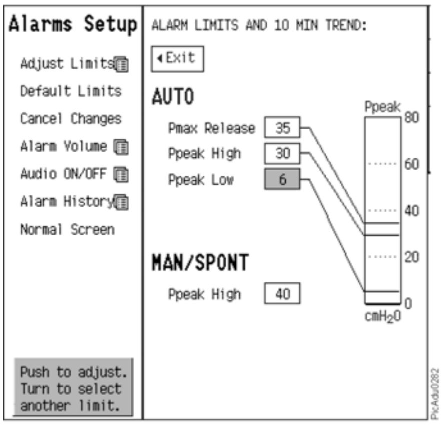
Select Page Page 1
Change Field ▤
Select Graph Ppeak
Graph Type Line
Graph Colour
Mix Colour
Graph Scale AUTO
Graph Height 50 %
Cursor On/Off ON
Previous Menu

Select graph page.

The following ***Alarm*** setting defaults may be configured**:**

- High and low alarms limits
  for any parameter
- Alarm volume
- Reminder volume

If the factory default settings for High and low alarm limits are changed, they cannot be reset by the factory defaults function. Resetting must be done manually


Alarms Setup
Adjust Limits
Default Limits
Cancel Changes
Alarm Volume
Audio ON/OFF
Alarm History
Normal Screen
ALARM LIMITS AND 10 MIN TREND:
Exit
Ppeak
80
60
40
20
0
cmH2O
PicAdu0282

AUTO

Pmax Release 35

Ppeak High 30

Ppeak Low 6

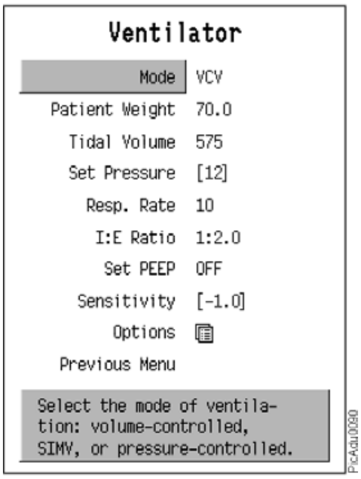
MAN/SPONT

Ppeak High 40

Push to adjust. Turn to select another limit.

The following ***Ventilator*** setting defaults may be configured:

- Tidal volume
- Set pressure
- Respiration rate
- I:E ratio
- Set PEEP
- Sensitivity
- Options


Ventilator
Previous Menu
PicAdu0090

Mode VCV

Patient Weight 70.0

Tidal Volume 575

Set Pressure [12]

Resp. Rate 10

I:E Ratio 1:2.0

Set PEEP OFF

Sensitivity [-1.0]

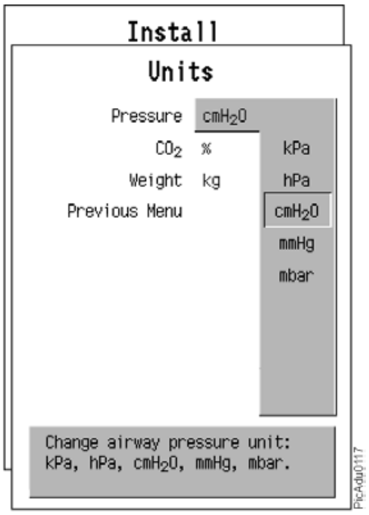
Options

Select the mode of ventilation: volume-controlled, SIMV, or pressure-controlled.

The following ***Units*** setting defaults may be configured in ***Install*** menu***:***

- Pressure
- CO_2
- I:E Times
- Weight
- Wall pressure

If any of the factory default settings I:E Times, Weight, Wall pressure are changed, they cannot be reset by the factory defaults function. Resetting must be done manually.


Install
Units
kPa
hPa
cmH2O
mmHg
mbar
Previous Menu
PicAdu0117

Pressure cmH2O

CO_2 %

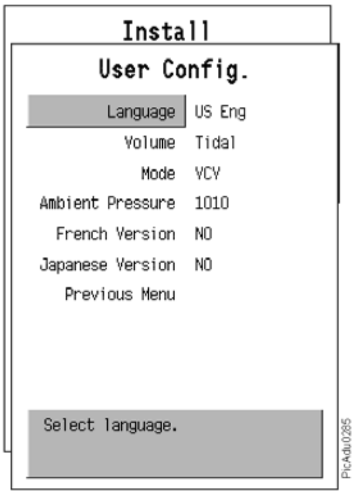
Weight kg

Change airway pressure unit: kPa, hPa, cmH_2O, mmHg, mbar.

The following ***User Configuration*** setting defaults may be configured in ***Install*** menu:

- Language
- Volume
- Mode
- Ambient pressure
- French and US version
- Japanese

If the factory default settings are changed for these functions, they cannot be reset by the factory defaults function. Resetting must be done manually.



Install

User Config.

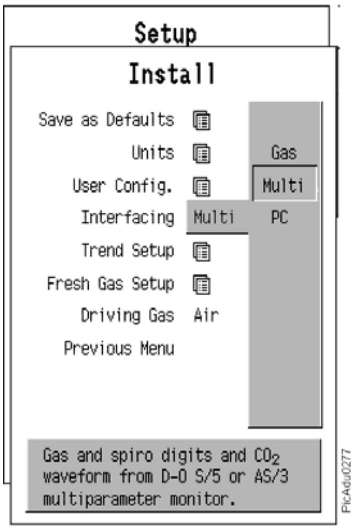
Language US Eng
Volume Tidal
Mode VCV
Ambient Pressure 1010
French Version NO
Japanese Version NO
Previous Menu

Select language.

The following ***Interfacing*** setting defaults may be configured in ***Install*** menu:

- Gas
- Multi
- None / PC

If the factory default settings are changed for these functions, they cannot be reset by the factory defaults function. Resetting must be done manually.



Setup

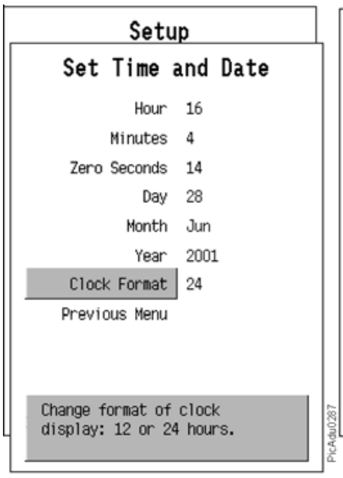
Install

Save as Defaults
Units
User Config.
Interfacing Multi
Trend Setup
Fresh Gas Setup
Driving Gas Air
Previous Menu

Gas and spiro digits and CO_2 waveform from D-O S/5 or AS/3 multiparameter monitor.

Date, ***Time*** and ***Clock*** format setting defaults may be configured from ***Setup*** menu.

If the factory default settings are changed for these functions, they cannot be reset by the factory defaults function. Resetting must be done manually.

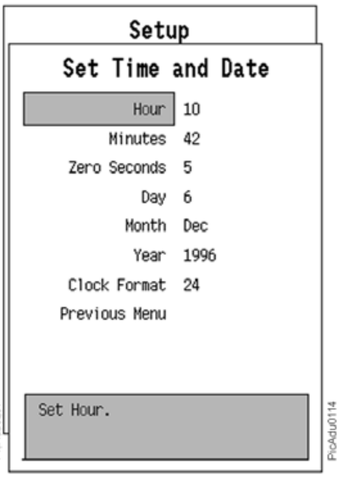


Setup

Set Time and Date

Hour 16
Minutes 4
Zero Seconds 14
Day 28
Month Jun
Year 2001
Clock Format 24
Previous Menu

Change format of clock display: 12 or 24 hours.



Setup

Set Time and Date

Hour 10
Minutes 42
Zero Seconds 5
Day 6
Month Dec
Year 1996
Clock Format 24
Previous Menu

Set Hour.

The “*Configuration worksheet*” is provided at the end of this section. By following it step by step, it is easy to decide which factory defaults to alter. As an example the basic screen layout: Trend settings, alarm settings, ventilator settings and measured parameters.

1. Write down the Identification No. of the unit(s) to be configured.
2. Check each item to be configured.
3. Circle or enter the new default.
4. Make the changes of the default configuration using the menus.
5. Save the changes as described in *“Saving the configuration”* paragraph below.

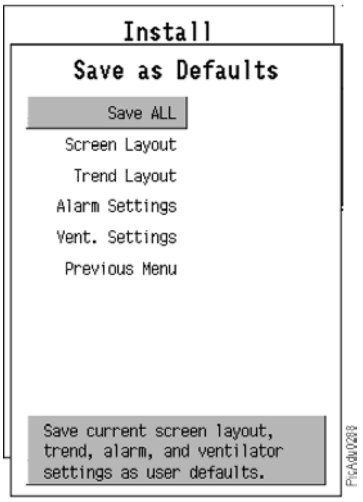
NOTE: The factory default for each item is within brackets.

After saving a new configuration into the permanent memory of each unit, it is suggested that you sign and date the worksheet and save it for your device history records. This is important for reconfiguring the defaults again if necessary.

Saving the configuration

When all the changes of the factory defaults for screens and parameters have been made, it is necessary to save them into the permanent memory. When the procedure is completed, the changes are permanent.

The entire screen layout: Trend setting, alarm setting and ventilator setting may be saved separately or at the same time by choosing ***Setup - Install - Save As Defaults - Save All.***



Save current screen layout, trend, alarm, and ventilator settings as user defaults.

Restart the ADU and check that the configuration corresponds to the values in the default configuration worksheet.

Default configuration worksheet

For the user configuration of the Datex-Ohmeda Anesthesia Delivery Unit.

Instructions

Use this form to select the function and parameter defaults to be changed and saved as a new default configuration. The ”Installation password” is needed for access to the selection menus.

1. Tick off the functions and parameters to be reconfigured and circle a desired default selection. The factory defaults are shown within brackets. N/A = Factory default that cannot be altered.
2. Use the menus to change the default configurations.

3. Go to SETUP/INSTALL to save the changes.
4. After configuration, save this identification page and other worksheet pages for future reference.

Identification of the configuration

Identification number for ADU frame, A-AUF, is located on back of the unit.

Fill in the customer or the hospital name, date of installation and signature of the person who performed the installation.

ADU Serial No:	Date: / /
Hospital:	Performed by:

Default configuration worksheet for the ADU (No. 1 of 4)

NOTE: Parameters with the prefix * can not be reset by the factory defaults function. Resetting must be done manually.

Setup - Screen layout

Parameter	**Default select. alternatives ( ) = factory set**	**User default Write down new choice!**
Show Menu Graphs	(NO) YES	
Flowmeter Height	Long Short (AUTO) OFF	
Show Total Flow	NO (YES)	
Middle Field	(Gases) Trends OFF	
Minute Volume	NO (YES)	
Inspiratory Pause	NO (YES)	
Extra I:E Times	NO (YES)	

Pcircuit setup

Field 1	Pcirc	N/A
Scale	Auto 10 20 (30) 40 60 80	
Sweep Speed	(Fast) Slow	
Color	White Red Green (Yellow) Blue Purple	

CO_2 setup

Field 2	OFF (CO_2)	
Scale	(6%) 10% 15%	
Sweep Speed	(Fast) Slow	
Color	(White) Red Green Yellow Blue Purple	

Set time and date

*Clock Format	12 (24)	

Install - Units

Pressure	kPa hPa (cmH_2O) mmHg mbar	
CO_2	(%) kPa mmHg	
*I:E Times	(Ratio) % sec	
*Weight	(kg) lb	
*Wall Pressure	(bar) PSI	

Install - User configuration

*Language	country specific; see menu (UK Eng)	
*Volume	(Tidal) Minute	
*Mode	(Volume) PCV	

*Ambient pressure	Sea level; 1013 mbar	
*French option	(No) /Yes	
* Japanese version	(No) /Yes	

Default configuration worksheet for the ADU (No. 2 of 4)

Install - Interfacing

*Interfacing	GAS (Multi) None/ PC	

Install - Trend setup

Select Page	(Page 1) Page 2 Page 3 (Page 4) (Page 5) (Page 6)	N/A
Page 1		
Select Graph	(Ppeak) Pplat Peep Pmin MV I:E Pause Vent.	
Graph Type	Cursor Pixel Curve (Line) Bar GapBar	
Graph Color	---	N/A
Mix Color	---	N/A
Graph Scale	(AUTO) 10 20 30 40 60 80	
Graph Height	0...100% (50%)	
Cursor on/off	(ON) OFF	
Page 2		
Select Graph	(TV) RR MV Vent	
Graph Type	Cursor Pixel Curve (Line) Bar (GapBar)	
Graph Color	Black White Red Green (Yellow)	
Mix Color	Black White Red Green Yellow Blue Purple Cyan	
Graph Scale	(AUTO) 10 20 30 40 60 80	
Graph Height	0...100% (50%)(30%)	
Cursor on/off	(ON) OFF	
Page 3		
Select Graph	(O2) N2O Air AA Vent	
Graph Type	Cursor Pixel Curve (Line) (Bar) GapBar	
Graph Color	---	N/A
Mix Color	---	N/A
Graph Scale	(AUTO) 10 20 30 40 60 80	
Graph Height	0...100% (50%)(30%)	
Cursor on/off	(ON) OFF	
Page 4		
Select Graph	---	
Graph Type	---	
Graph Color	---	N/A

Mix Color	---	N/A
Graph Scale		N/A
Graph Height		N/A
Cursor on/off	(ON)OFF	
Page 5		
Select Graph	---	
Graph Type	---	
Graph Color		N/A
Mix Color		N/A
Graph Scale		N/A
Graph Height		N/A
Cursor on/off	(ON) OFF	
Page 6		
Select Graph	---	
Graph Type	---	
Graph Color		N/A
Mix Color		N/A
Graph Scale		N/A
Graph Height		N/A
Cursor on/off	ON (OFF)	

Default configuration worksheet for the ADU (No. 3 of 4)

Install - Trend setup - Change field

Field 1	OFF; (Ppeak,.); Vent ; TV; RR; MV; O_2; N_2O, Air; AA; I:E; Pause; I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
Field 2	OFF; Ppeak,.; Vent ; TV; RR; (MV); O_2; N_2O, Air; AA; I:E; Pause; I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
Field 3	OFF; Ppeak,.; Vent ; TV; RR; MV; O_2; N_2O, Air; AA; (I:E); Pause; I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
Field 4	OFF; Ppeak,.; Vent ; TV; RR; MV; O_2; N_2O, Air; AA; I:E; (Pause); I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
Field 5	OFF; Ppeak,.; (Vent) ; TV; RR; MV; O_2; N_2O, Air; AA; I:E; Pause; I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
(Field 6)	(OFF); Ppeak,.; Vent ; TV; RR; MV; O_2; N_2O, Air; AA; I:E; Pause; I:E, Pause; Total; O_2%; CO_2, He; CO_2; He; Total; I:E, Pause; O_2, N_2O; Tcyc, Ex	
Select Page	(Page1) Page 2 Page 3 (Page 4) (Page 5) (Page 6)	N/A

Ventilator

Parameter	**Default select. alternatives ( ) = factory set**	**User default Write down new choice!**
Mode	(Volume) PCV SIMV Only Volume or PCV mode can be configured as start-up default modes. This is done in the Install-/User Configuration menu	
Tidal Volume	20...1400 (500)	
Set Pressure	5...40 (12)	
Resp. Rate	2...60 (10)	
I:E Ratio	1:4.5 1:3.0 1:2.5 (1:2.0) 1:1.5 1:1.0 2:1.0	
Sensitivity	-5.0...-0.5 (-1.0)	
Set PEEP	(OFF) 5----20	N/A

Default configuration worksheet for the ADU (No. 4 of 4)

Ventilator - Options

Trigger Window	5 - 95 % (50 %)	
Inspiratory Pause	OFF 5 10 15 20 (25) 30 35 40 45 50 55 60	
Inspiratory Rise	Slow (Medium) Fast	
Sigh	ON(OFF)	N/A

Alarm setup

Parameter	**Default select. alternatives ( ) = factory set**	**User default Write down your choice!**
Alarm Volume	1 2 3 4 (5) 6 7 8 9 10	
Audio ON/OFF	(Activate Alarms) Silence All	N/A
Reminder Volume	0...10 (5)	

Alarm setup - Adjust limits

AUTO Ppeak low	6...(Ppeak High - 2) (6)	
AUTO Ppeak High	(Ppeak Low + 2) ... 80 (30)	
AUTO Pmax release	(Ppeak High)...80 (40)	
MAN SPONT Ppeak High	6...80 (40)	

Display trends - Trends

Parameter	**Default select. alternatives ( ) = factory set**	**User default Write down your choice!**
Graph Time	24h 12h 4h (2h) 20m	N/A
Graphical	<	
Numerical	<	

Display trends - Set scales

TV (ml)	(AUTO) 150 300 600 900 1500	
RR (1/min.)	(AUTO) 20 40 60	
MV (l/min.)	(AUTO) 5 10 15 20	
Ppeak (cmH_2O or selected unit)	(AUTO) 10 20 30 40 60 80	
Tcyc, Texp, Tinsp, Tpause (s)	(AUTO) 5 10 15 20	
Vent, I:E, Pause (-)	AUTO	N/A
O_2, N_2O, Air (l/min.)	(AUTO) 1 2 5 10 15	
Total (l/min.)	(AUTO) 1 2 5 10 15	
AA (%)	(AUTO) 1 2 3 5 10 18	
O_2% (%)	(AUTO) 50 100	

5 MAINTENANCE

Schedule and maintenance kits

For safe, reliable function and operation of the ADU, regular maintenance must be carried out as described in the "*User's Reference Manual*" supplemented by the maintenance procedures in this section.

There are four different check and maintenance procedures for the ADU, which should be carried out according to the schedule below.

Check	**Maintenance interval**			
	Daily	**6 months**	**1 year**	**3 years**
System check	X			
Functional check		X		
One year maintenance			X	
Three year maintenance				X

NOTE: In addition to the procedures in the table above, some additional maintenance is required at the 6th and 8th year interval. See *"Other Maintenance" section*.

System check

Always carry out the System Check after Functional Check, maintenance or service.

Always carry out Auto and Manual leak tests when suspecting a leak or after exchange/service of the patient circuit.

The System Check is described in the *"User's Reference Manual"*.

Functional check

The Functional Check should be carried out every six months and always after servicing the ADU. Specified test equipment must be used.

One year maintenance

Use One Year Maintenance Kit.

Three year maintenance

Use One Year and Three Year Maintenance Kits.

CAUTION	Before a maintenance/repair, disconnect gas supply and depressurize the ADU. Then disconnect the unit from the mains power.
CAUTION	Cover the table top to protect it from damage.
CAUTION	Always use correct tools and test equipment to avoid damage.

Tools

- 1 set of Allen ball tipped screwdrivers 1.5 - 10 mm
- 1 set of Allen wrenches (angled) 1.5 - 10 mm
- 1 set of cross-head Pozidriv screwdrivers: 1, 2, 3
- 1 set of open-ended wrenches 6 - 21, 24 mm
- Box wrench 10 mm
- Socket wrench, 14 mm
- Flat blade screwdrivers
- PTFE-based lubricant (oxygen safe)
- Leak-finding spray

Test equipment needed for the Functional check

- Calibrated test device and fittings for measuring flows, pressure and volume.

NOTE: The ADU is calibrated in ATP (ambient temperature and pressure). Make sure that the test device is set to ATP mode, assuming the test gas temperature is 21°C (70°F).

- Capnomac Ultima, AM with Gas Module or other gas monitor.
- Multimeter
- Aladin, Enflurane or Sevoflurane cassette
- Electrical safety tester
- Test lung (2 litter manual bag)
- High pressure tester or Datex-Ohmeda high pressure test adapter (P/N 8500002)
- Cassette pressure adapter (P/N 8500006). Note that this tool is only necessary during calibration.
- Pilot pressure connector for (P/N 735096). Note that this tool is only necessary during calibration and check of the inlet pressure regulator.
- Test resistans when performing Tidal Volume test (P/N 535335100).

Service menu

Entering the Service Menu is necessary for:

- Functional Check
- Calibrations
- Troubleshooting and diagnostics

To enter the service menu

1. Push the **Setup** key.
   The ***Setup*** menu will appear on the ADU main display.
2. Turn the **ComWheel**, select ***Service*** on the menu and push the **ComWheel**. A scale for selection of Password (digit combination) appears.
3. Enter either the 'Diagnostics Password' or the 'Calibrations Password' thereby gaining access to the Service Menus. See the following paragraph for definitions.

Passwords

‘Diagnostics Password’ gives access to all Service Menu pages but not to the Calibration Menu pages.

‘Calibrations Password’ gives access to all Service Menu pages. It is also possible to alter calibration values and to reset Error History.

Layout of service/diagnostics and calibrations pages

Each page contains a list of items and a blue message field. An item is selected (lights up) by turning the **ComWheel.** The selected item is then entered by pushing the **ComWheel**. A “page symbol” after an item on the list, indicates that there are one or more submenus.

At the bottom of the lists is the item ***Previous Menu*** shown, which should be selected for returning to proceeding pages. Close to the Service Menu is the ‘Software Version/Unit Id page’, stating system configuration and other data.

Service menu overview

The diagram below shows an overview of the structure of the Service Menu layout.

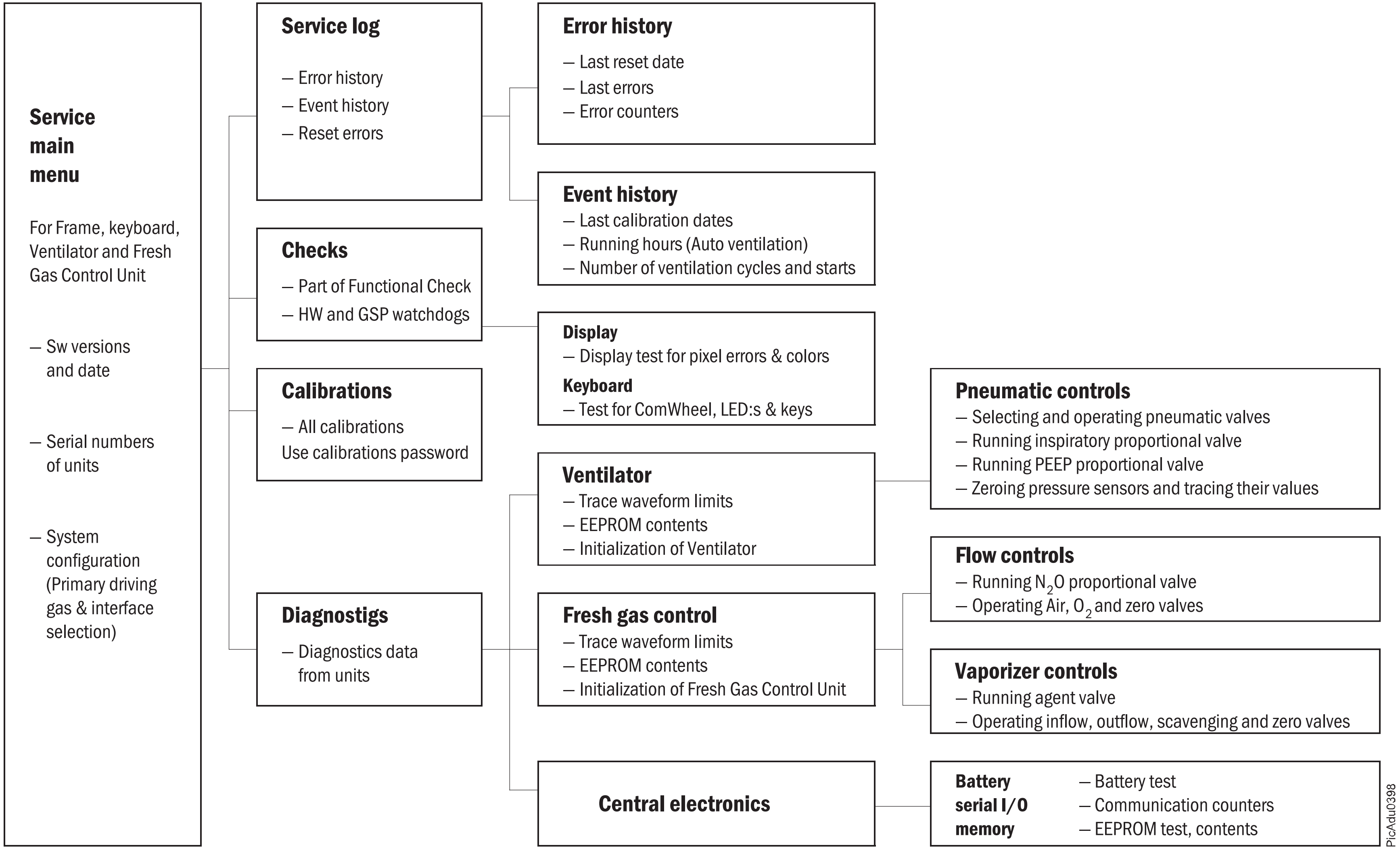

Service main menu
For Frame, keyboard, Ventilator and Fresh Gas Control Unit
– Sw versions and date
– Serial numbers of units
– System configuration (Primary driving gas & interface selection)
Service log
– Error history
– Event history
– Reset errors
Checks
– Part of Functional Check
– HW and GSP watchdogs
Calibrations
– All calibrations
Use calibrations password
Diagnostigs
– Diagnostics data from units
Error history
– Last reset date
– Last errors
– Error counters
Event history
– Last calibration dates
– Running hours (Auto ventilation)
– Number of ventilation cycles and starts
Display
– Display test for pixel errors & colors
Keyboard
– Test for ComWheel, LED:s & keys
Ventilator
– Trace waveform limits
– EEPROM contents
– Initialization of Ventilator
Fresh gas control
– Trace waveform limits
– EEPROM contents
– Initialization of Fresh Gas Control Unit
Central electronics
Pneumatic controls
– Selecting and operating pneumatic valves
– Running inspiratory proportional valve
– Running PEEP proportional valve
– Zeroing pressure sensors and tracing their values
Flow controls
– Running N2O proportional valve
– Operating Air, O2 and zero valves
Vaporizer controls
– Running agent valve
– Operating inflow, outflow, scavenging and zero valves
Battery
serial I/O
memory
– Battery test
– Communication counters
– EEPROM test, contents
PicAdu0398

Figure 1 **Service menu overview**

Maintenance procedures

Step 0: Preparations before installation of maintenance kits

Disassembly and reassembly of covers

Tools: Allen wrench 4 mm

1. Remove the pipeline gas supplies and disconnect the mains.
2. Remove the 8 Allen screws securing the rear plastic cover. To remove the side panels (2, 3 and 4) remove the Allen screw with toothed washer.

NOTE: If an external Electrical Outlet box is installed, it must be removed to replace the fan filter or if the central electronics requires service.

3. Remove the power cable from the central electronics unit.
4. Remove the 2 screws with toothed washers, securing the Electrical Outlet box (5).
5. Reassemble in reversed order.

NOTE: Do not forget the washers.

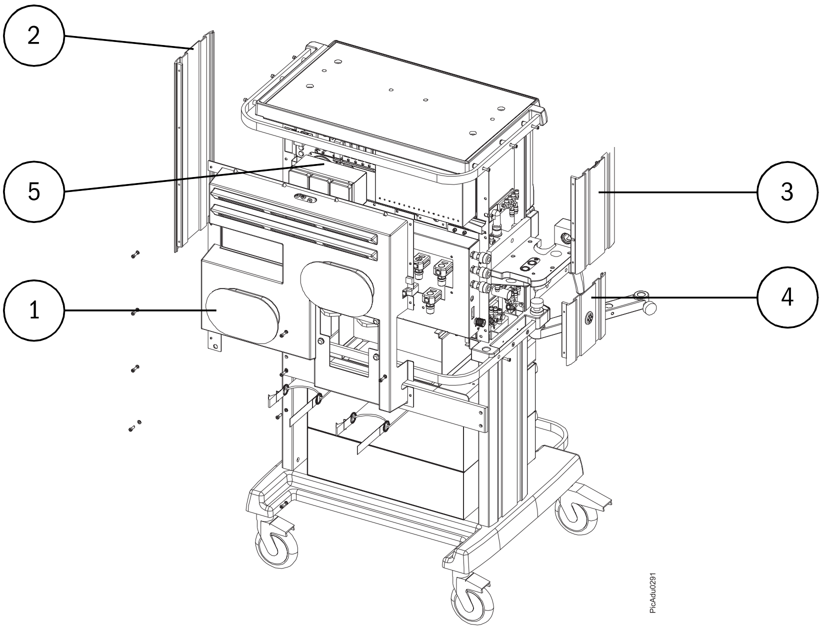


Figure 2 **Disassembly and reassembly of covers**

Disconnecting gas and power supply

1. Disconnect the gas supplies from the ADU.
2. Turn the N_2O/Air switch to N_2O position.
3. Drain the N_2O pressures from the ADU by opening the N_2O flow control fully and setting the O_2 flow control to 1 liter/min.
4. Turn the N_2O/Air switch to Air position and open the Air flow control to drain the air pressure.
5. Power off the ADU and disconnect the mains power.

One year maintenance

Step 1: Replacing the gas inlet o-rings

Spare parts: *Gas inlet O-rings (3 pcs) 65399 for NIST connectors*
Tools: *Wrench*

1. Remove the gas supply hoses from the A-WGU gas inlet connectors and replace the O-rings supplied in the one year kit.
2. Refit the gas supply hoses to the A-WGU.

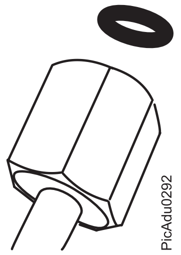


Figure 3 **Gas inlet o-ring**

Step 2: Replacing the gas filters and gaskets in the Wall Gas Unit

Spare parts: *Gas filter (O_2, Air, N_2O) (3 pcs) 57142*
Gas filter gaskets (3 pcs) 0020068074
Tools: *Box wrench 10mm*

1. Unscrew the retainers (1) and take out the filters (2).
2. Remove gasket (3) on the retainers.
3. Fit new filters and gaskets. Tighten the retainers.

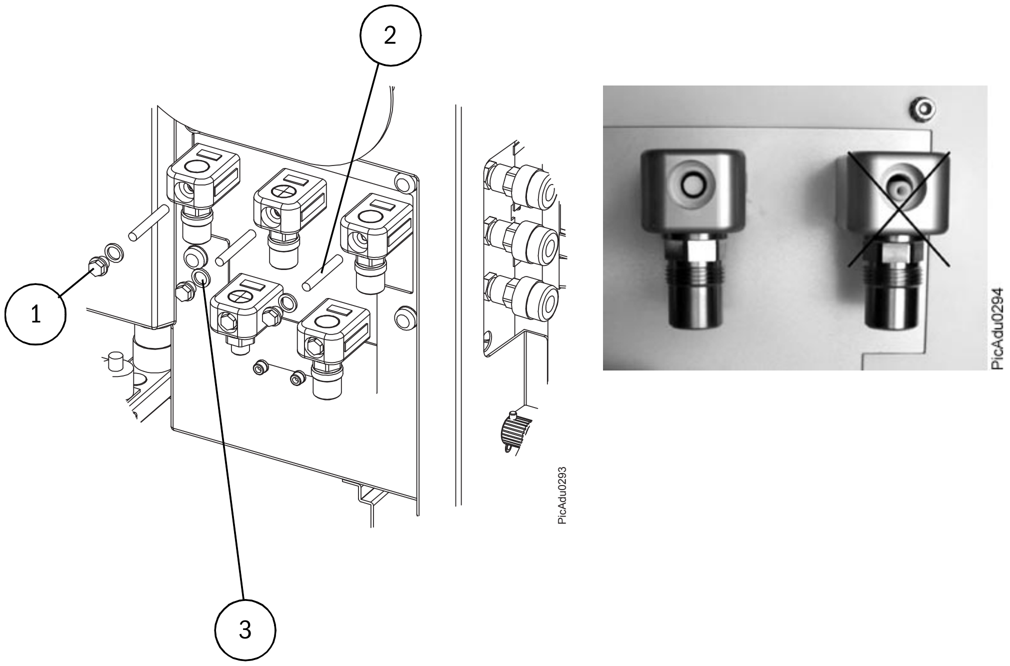


Figure 4 **Gas filters and gaskets replacement. Make sure that the filter is inserted correctly.**

Step 3: Replacing the dust filter

Spare parts: Dust filter 871558

Replace the dust filter at the back of the Central Electronics unit.

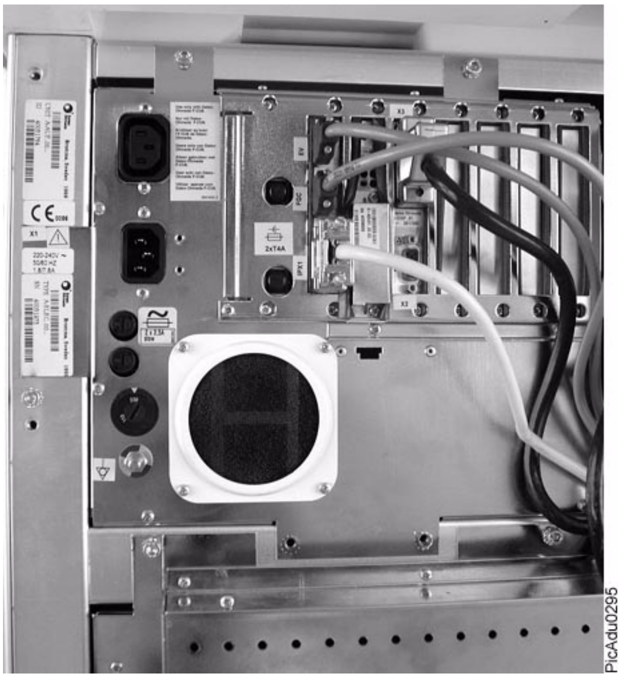


Figure 5 The dust filter

Step 4: Replacing the gasket between the Bellows Block and the Bottom Plate

Spare parts: Gasket 886394

Replace bottom plate gasket underneath the bellows block with the new one from the kit.

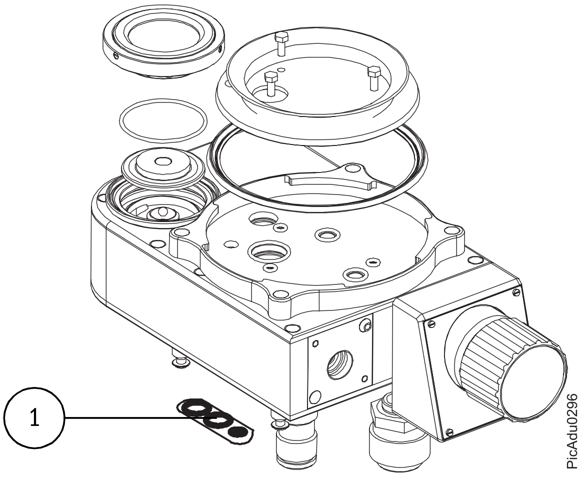


Figure 6 Bottom plate with gasket

Step 5: Replacing the O-rings in the APL valve of the Bellows Block

Spare parts: APL valve O-ring, (2 pcs) 656391

APL valve O-ring, 656505

Remove old O-rings (1) and (2) and replace them with new ones. Apply a thin layer of PTFE based lubricant to the new O-rings.

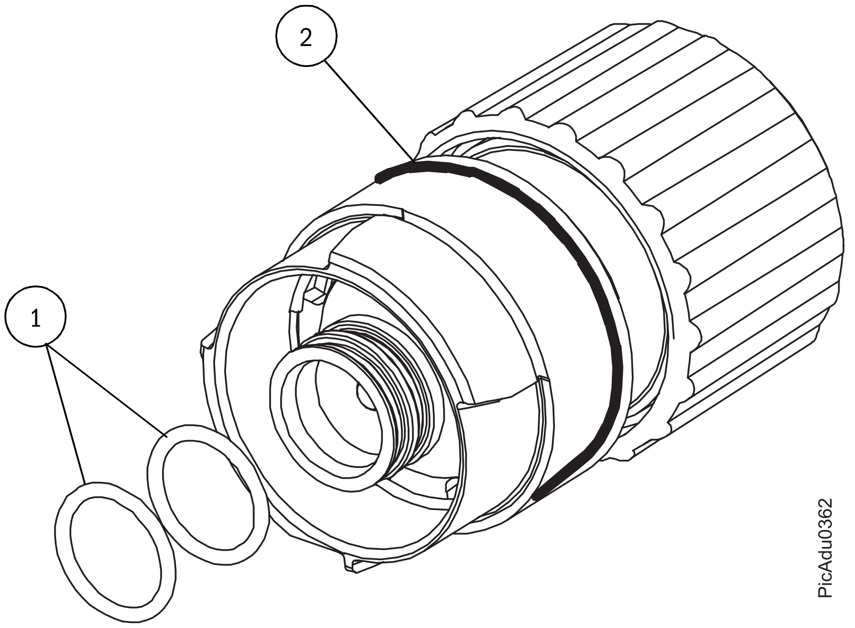


Figure 7 APL valve O-rings

Step 6: Replacing the o-rings on the Bellows Block connectors

Spare parts: *O-ring for Patient Circuit connector, 65374 (1)*

O-ring for Manual Bag connector, 656507 (2)
located inside the connector

Replace both O-rings with new ones supplied in the kit. Coat the new O-rings with a thin layer of PTFE based lubricant. See the figure below.

Step 7: Replacing o-ring and membrane in the Bellows Unit overflow valve

Spare parts: *Overflow valve membrane 889112 (Item 4)*

Overflow valve o-ring 656498 (Item 3)

1. Remove the valve cap (5).
2. Replace old membrane (4) with the new one in the kit

NOTE: Do not apply any lubricant on the membrane.

3. Replace O-ring (3) with the new one in the kit. Apply a thin layer of PTFE based lubricant to the O-ring and replace valve cap (5)

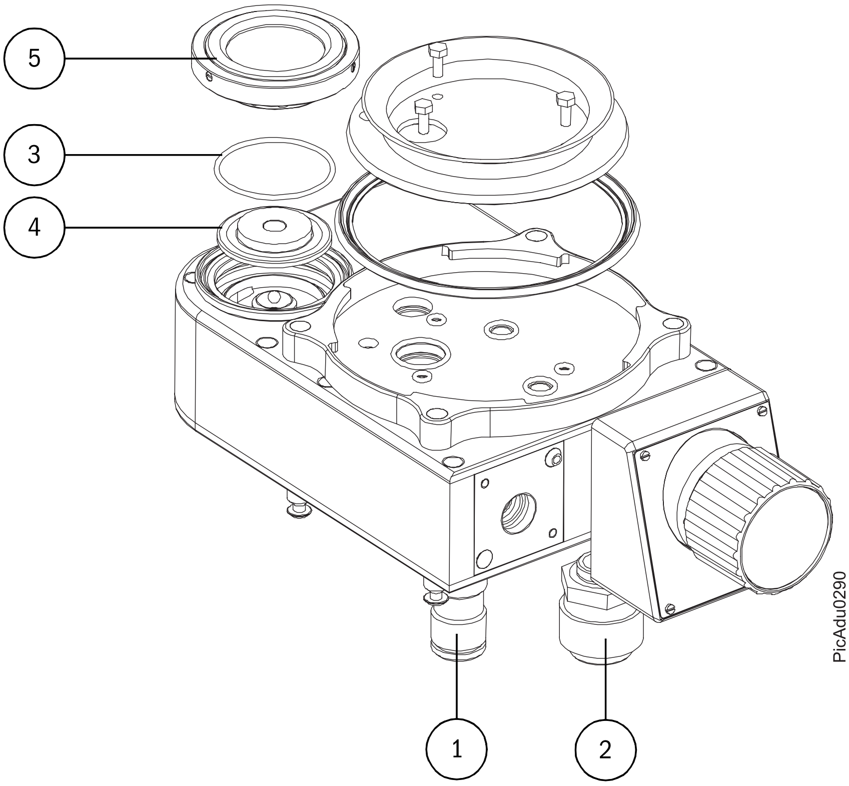


Figure 8 **O-rings and membrane in the Bellows block**

Step 8: Replacing the O-ring on the Fresh Gas Outlet

Spare parts: O-ring for Fresh Gas Outlet 65374

Replace the O-ring on the Fresh Gas Outlet with the new O-ring supplied in the kit.

Step 9: Replacing the O-rings in cassette housing

Spare parts: O-rings (2 pcs) 65371

1. Pull out the Aladin cassette and remove the O-rings in the bottom of the cassette slot. Use a suitable tool as a dental peg.

NOTE: Be careful when removing the old O-rings. Scratches on the cassette slots may cause leaks.

2. Apply a thin layer of PTFE based lubricant to the new O-rings supplied in the kit, and install them on the two inlet valves.

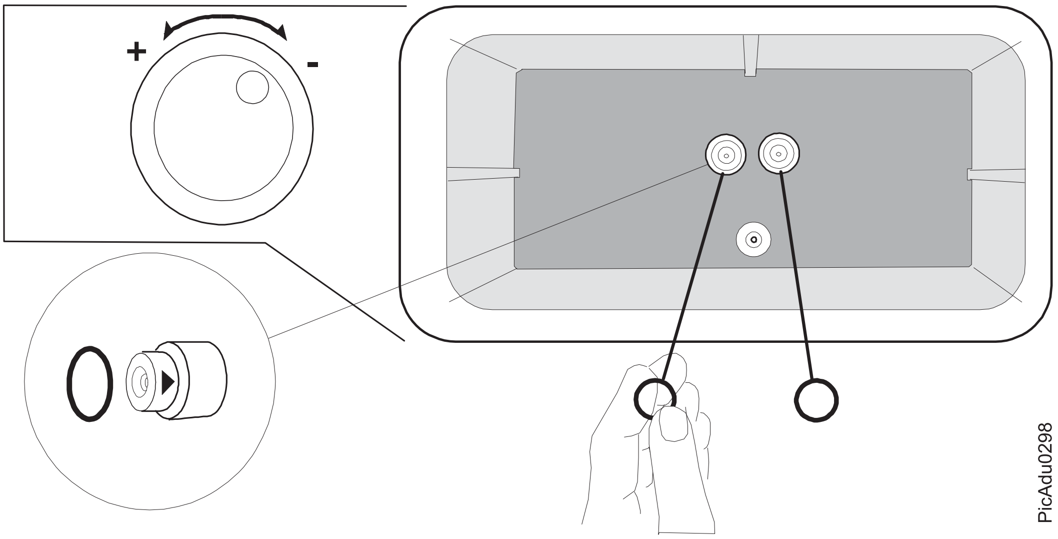


Figure 9 Cassette slot O-rings

Step 10: Replacing the reservoir tube

Spare parts: *Reservoir tube 8500074*

Straps 00036008

Tools needed: *Allen wrench, 4 mm*

The reservoir tube is located in a ”tray” which is accessible behind the side panels of the unit.

1. Disconnect the end of the tube (1) from its connector on the left side of the unit.
2. Remove the 2 screws holding the tray in place (2) on right side of the unit and carefully pull out the tray.
3. Note how the reservoir tube is routed and then remove it.
4. Fit the new tube from the kit into the tray in the same way as the old one was routed. If the new tube does not fit well to the connector in the tray then the straps in the kit should be used to secure it.
5. Reinstall the tray and secure it with the two screws. Note that one end of the tubing should stick out a bit so that it can reach the connector in step 1.
6. Connect the reservoir tube to the connector (1).
7. Reassemble panels in reversed order.

NOTE: Make sure the seal (3) is properly installed and take care to not harm the ON/OFF standby cable, when reinstalling the tray.

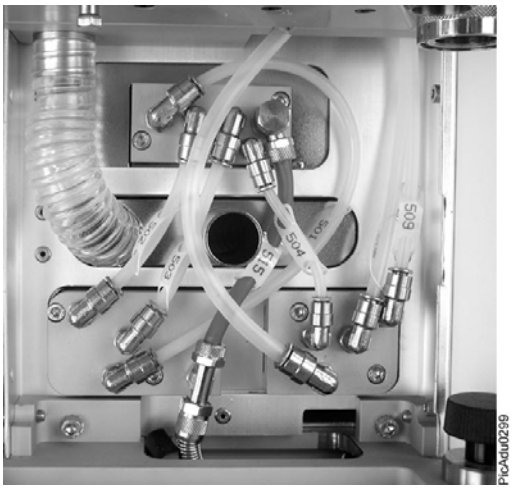


Figure 10 Reservoir tube connector

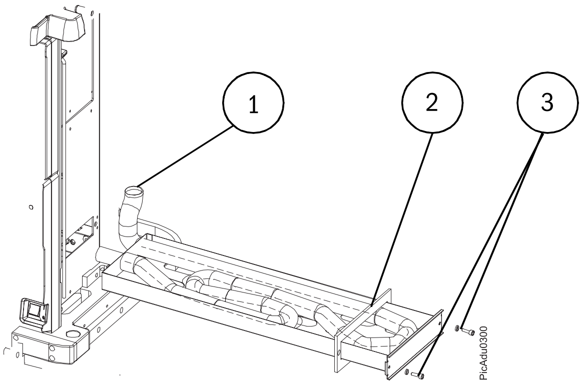


Figure 11 Tray for reservoir tube

Three year maintenance

Step 11: replacing the expiration and PEEP valve membranes and O-rings

Spare parts:	*Expiration valve membranes (2 pcs) 886432*
	O-rings (3pcs) 65363
	O-ring (1pcs) 050083349
Tools:	*Crosshead Pozidriv screwdriver*
	Allen wrench 2, 5 and 3 mm

NOTE: Do not use membranes older than three years!

1. Take out the EXP. and PEEP valve housing cover by unscrewing the two screws.
2. Take out the EXP. and PEEP valve housing assembly from the ventilator by unscrewing the two Allen screws.

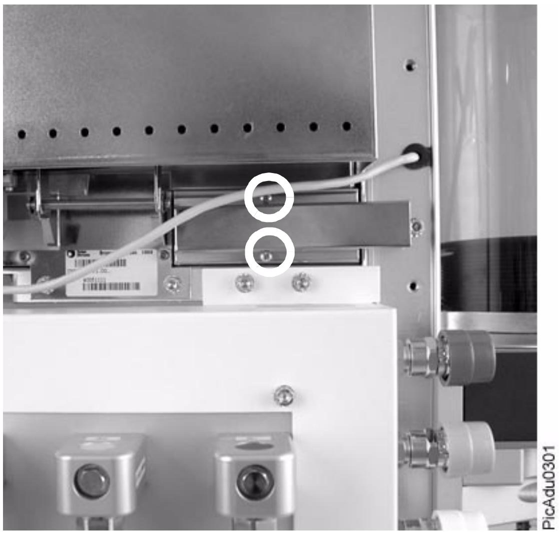


Figure 12

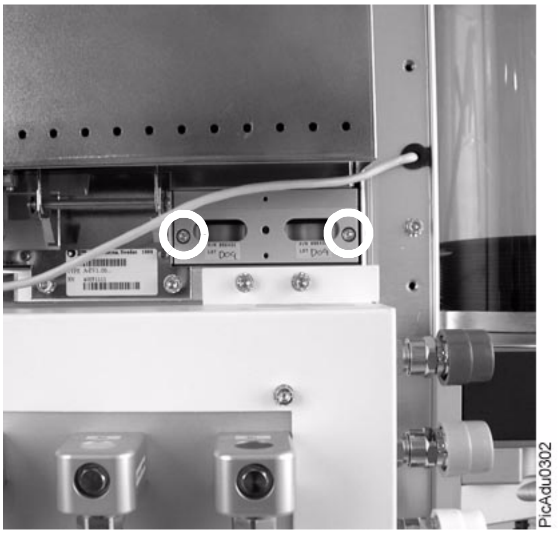


Figure 13

3. Unscrew the six Allen retaining screws and remove the lid of the expiration valve housing.

4. Replace the valve membranes (item 1 in picture below).

NOTE: Be sure that new membranes are well seated around the steel plates before reinstalling the valves in the housing.

NOTE: Do not apply any kind of lubricant to the membranes

5. Refit the lid and tighten the six Allen screws.

NOTE: Make sure the edge of the lid is mounted in line with the valve hose.

6. Exchange the three O-rings (2) and the large O-ring (3). Check that the O-rings are correctly seated before reassembling the valve into the Ventilator.
7. Remove the old yellow label (indicates lot number for the membranes) and attach the new one from the kit.
8. Reinstall the valve assembly, housing seal and cover.

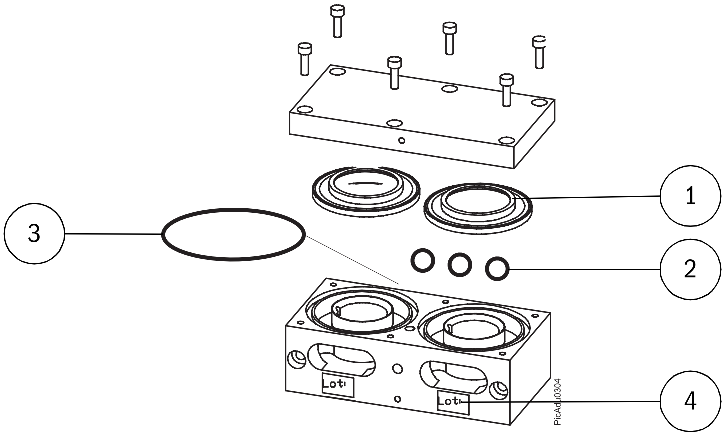


Figure 14 Expiration valve membranes

Step 12: Replacing the batteries in the Central Electronics (Three years)

Spare parts: *Batteries (4 pcs) 891389*

Tools: *Allen wrench 4mm*

Cross-head Pozidriv screwdriver

NOTE: All batteries must be replaced at the same time.

NOTE: Screws 63611 and 61721 are used to fasten top and side covers. Replace worn screws.

Preparations (removal of covers)

1. Disconnect mains, A-EV1, A-FGC1, Display and On/Standby cables from the Central Electronics unit. See pictures below.
2. Unfasten the 4 Allen screws that hold the upper and lower part of the module frame, see picture below. If an A-EO box is mounted it should be removed first. It is secured by the two lower screws.

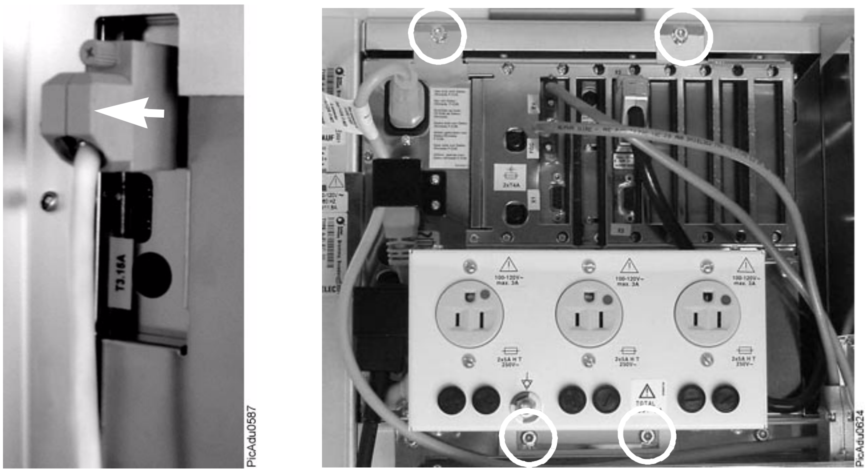


Figure 15 **Disconnecting the On/Standby switch cable and removing the four Allen screws**

3. Pull out the A-ELEC from the frame.
4. Remove the top cover from the A-ELEC by removing the three screws (1) and unlocking the two screws (2) as figure below.

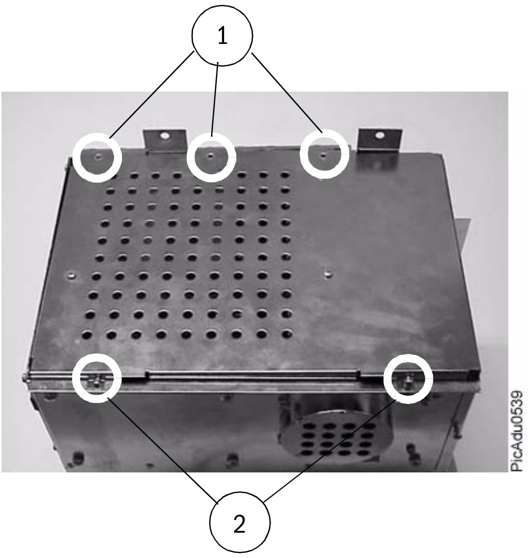


Figure 16 **Removing top cover from the A-ELEC**

5. Remove both side covers, by unlocking the screws on each side, see figure below.

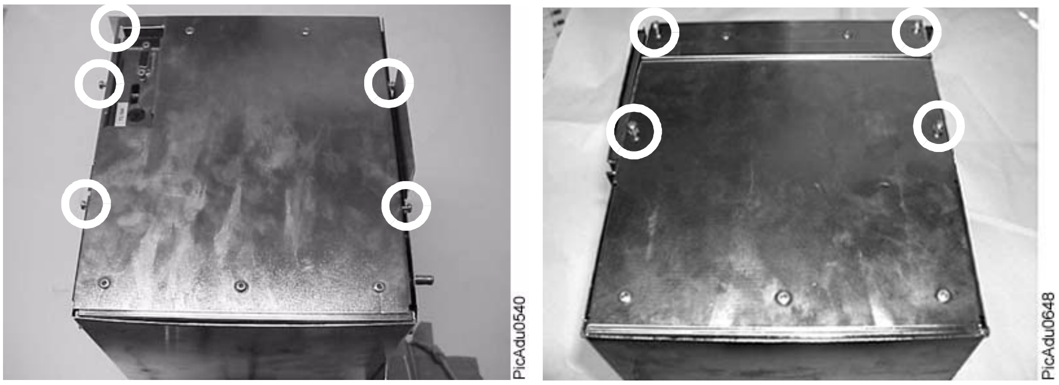


Figure 17 **Removing the A-ELEC side cover by unlocking screws**

6. Unfasten the 4 screws (see figure below) securing the Mains board to the A-ELEC and carefully fold it down .

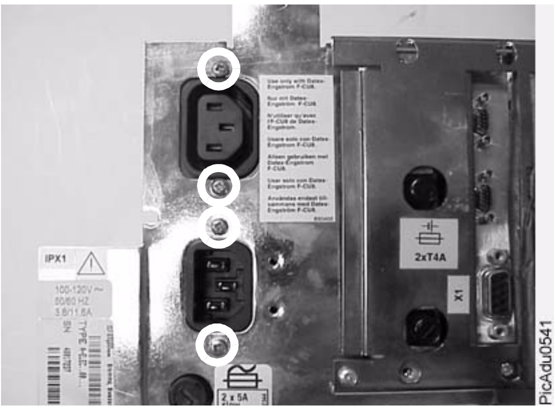


Figure 18 **Screws securing the mains board**

7. Disconnect ground cable (Green/Yellow) and transformer cables: Blue (X8), Black or Green (X7) and Brown or White (X6) from the mains board as figure below.

NOTE: On A-ELEC1 modules with power conversion kit installed (a label with the text *"8503007 INSTALLED"* is applied on the back of the A-ELEC1) has the transformer cables other colors: X8 Blue / X7 Green / X6 White.

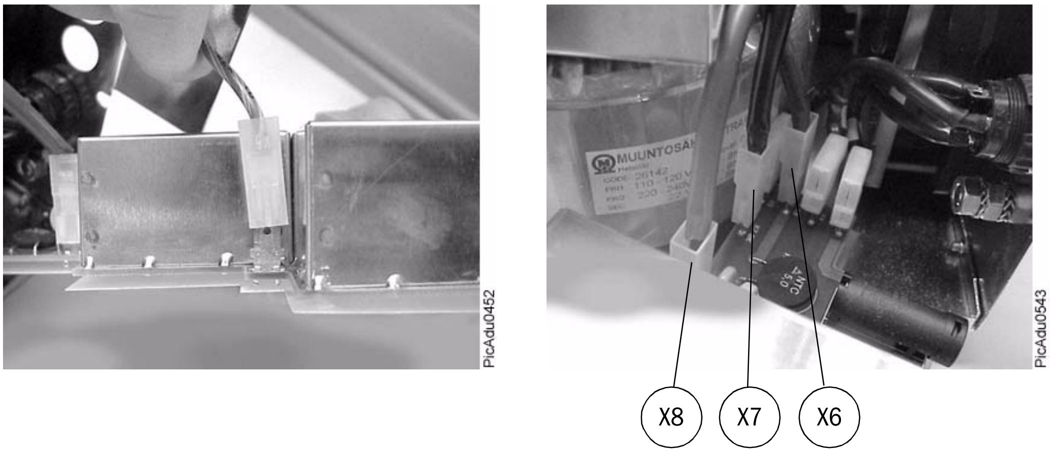


Figure 19 **Disconnecting the green/ yellow cable and the three transformer cables**

8. Disconnect the cables Yellow (X2) and Black (X3) from the rectifier board.

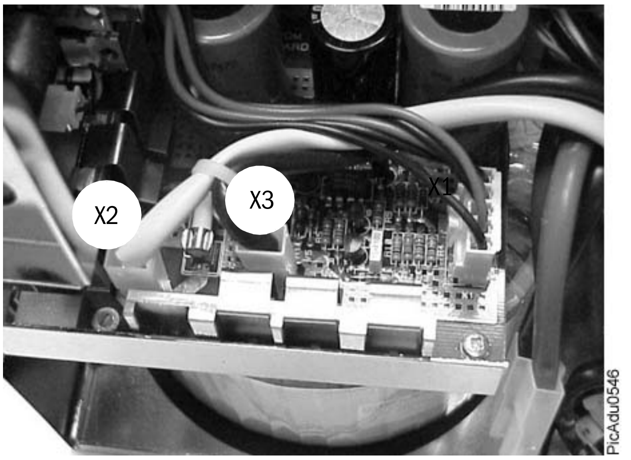

X2
X3
X1
PicAdu0546

Figure 20 Rectifier board socket connections

9. Remove the 4 screws (2 at each side of the A-ELEC module) that hold the battery and transformer tray as figure below.

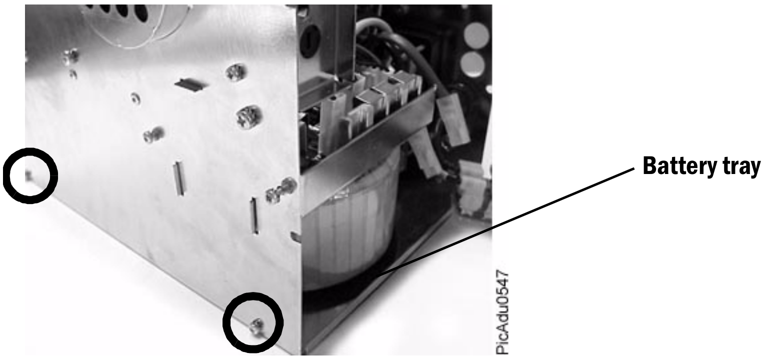

Battery tray
PicAdu0547

Figure 21 The screws that hold the battery and transformer tray

10. Remove the battery charger board fuses (only for protection during the replacement ot the batterries) as figure below.

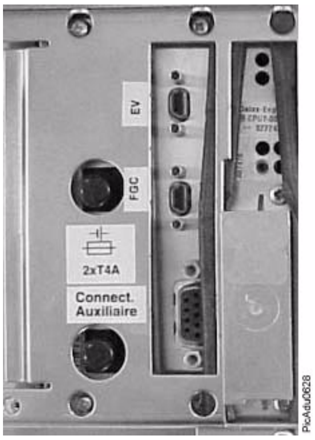
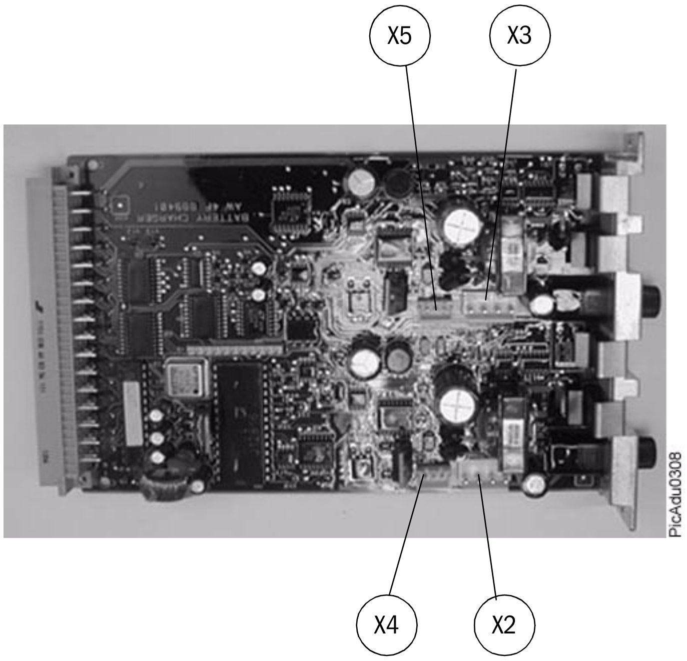

EV
FGC
2xT4A
Connect.
Auxiliaire
PicAdu0628

Figure 22 The battery charger board fuses removed

11. Disconnect the following wires connected to the Battery charger board connections X2, X3, X4 and X5 as figure below.



Connections chager board	
X2	BAT A
X3	BAT B
X4	TEMP A
X5	TEMP B

Figure 23 Battery charger board

12. Push out the battery transformer assembly tray from the A-ELEC, push from the the transformer side.
13. Remove the two battery holder screws (6) in table below.
14. Remove the cables attached to the batteries poles (2), (3) and replace the batteries (1). See label inside cover or figure below for correct attachment of battery cables and temperature sensor connection.

NOTE: Be sure that the temperature sensors (4), (5) are placed between the holder and batteries during reassembling.

Item	Item description
1	Battery, lead-acid 12V, 2.0 Ah (includes 4 pieces)
2	Battery cable BATT A
3	Battery cable BATT B
4	Temperature cable TEMP A
5	Temperature cable TEMP B
6	Battery holder screw

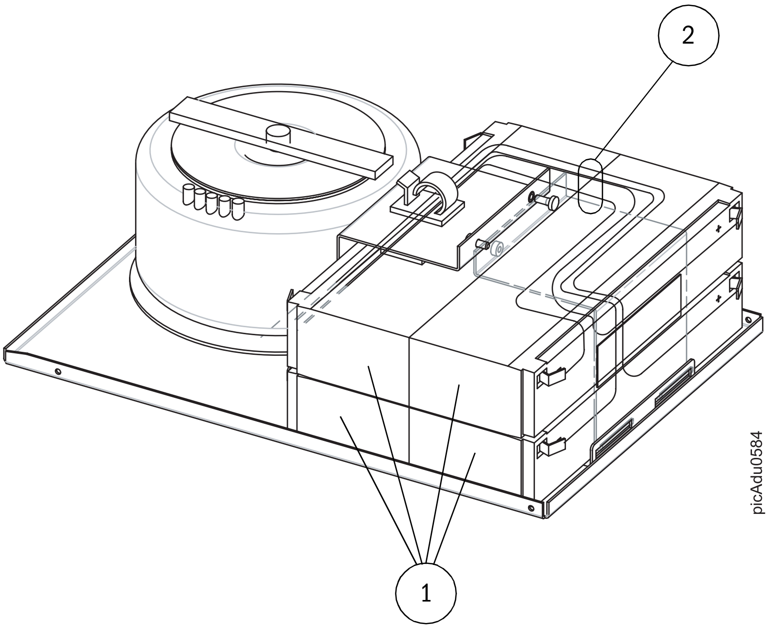

2
1
picAdu0584

Figure 24 **Transformer unit**

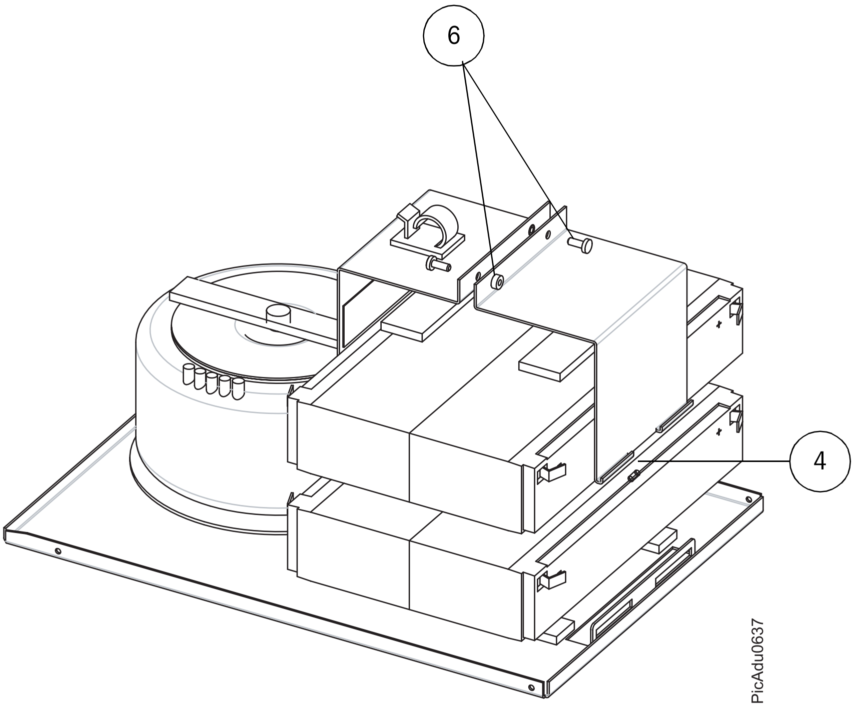

6
4
PicAdu0637

Figure 25 **Transformer unit**

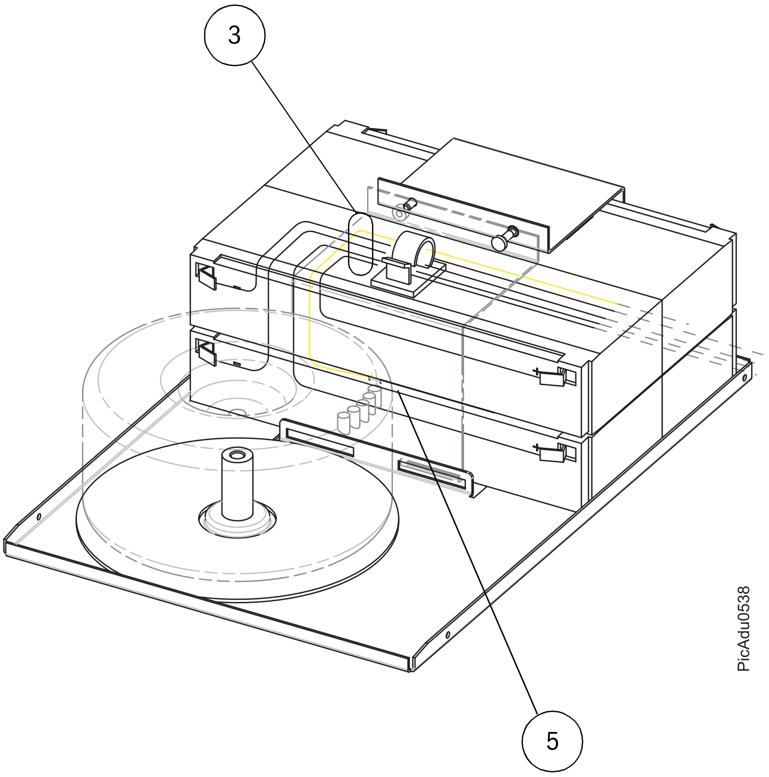

3
5
PicAdu0538

Figure 26 **Transformer unit**

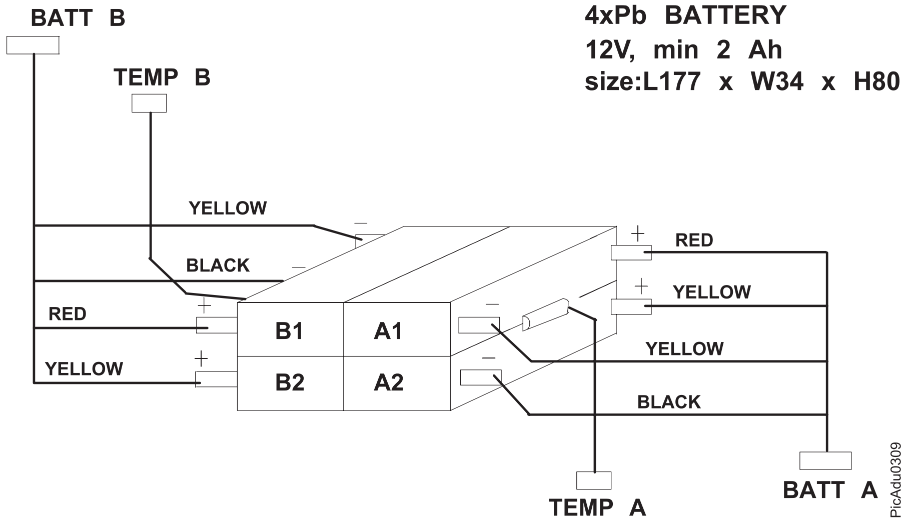

BATT B
TEMP B
4xPb BATTERY
12V, min 2 Ah
size:L177 x W34 x H80
YELLOW
BLACK
RED
YELLOW
B1
A1
B2
A2
RED
YELLOW
YELLOW
BLACK
TEMP A
BATT A
PicAdu0309

Figure 27 **Battery cable connectors**

NOTE: Battery cover is also labeled

15. Reassemble all parts and covers in reversed order.

Step 13: Checking the error detection function of the vaporizer heating resistor

Tools: *Allen wrench 4 mm*

Cross-head Pozidriv screwdriver

1. Open the cover of the fresh gas unit by removing its retaining screws (9 Pozidriv and 4 Allen screws).
2. Detach the 2-pin heater connector (X10) from the Connection Board.
3. Install an Aladin cassette and verify the ADU unit does not recognize the cassette.
4. Reconnect the 2-pin heater connector to the Connection Board.
5. Install the Aladin cassette and check that it now is recognized by the ADU.

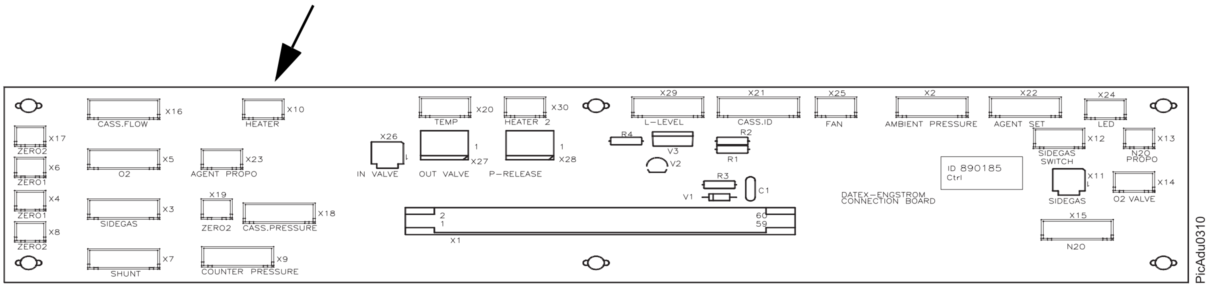

X16
CASS.FLOW
X10
HEATER
X20
TEMP
X30
HEATER 2
X29
L-LEVEL
X21
CASS.ID
X25
FAN
X2
AMBIENT PRESSURE
X22
AGENT SET
X24
LED
X17
ZERO2
X6
ZERO1
X4
ZERO1
X8
ZERO2
X5
O2
X23
AGENT PROPO
X26
IN VALVE
X27
OUT VALVE
X28
P-RELEASE
1
1
R4
V3
V2
R2
R1
R3
C1
V1
X3
SIDEGAS
X19
ZERO2
X18
CASS.PRESSURE
2
1
60
59
X1
DATEX-ENGSTROM
CONNECTION BOARD
ID 890185
Ctrl
X12
SIDEGAS
SWITCH
X13
N2O
PROPO
X11
SIDEGAS
X14
O2 VALVE
X15
N2O
X7
SHUNT
X9
COUNTER PRESSURE
PicAdu0310

Figure 28 **FGC1 Connection board**

Step 14: Changing the chamber seal and o-rings of the Bellows Block

Tools:	*Crosshead Pozidriv screwdriver (PDZ1)*	
Spare parts:	*Chamber seal*	*886412*
	O-rings	*65394 (3 pcs)*
		656499 (2 pcs)
		65389 (1 pcs)

1. Remove the three retaining screws and bellows collar (1).
2. Remove the bellows chamber seal (2).
3. Replace the five old O-rings (3) with the new ones provided in the kit. Apply a thin layer of PTFE based lubricant on the new O-rings.
4. Reassemble the Bellows Block in reversed order using the new bellows chamber seal (2) from the kit.

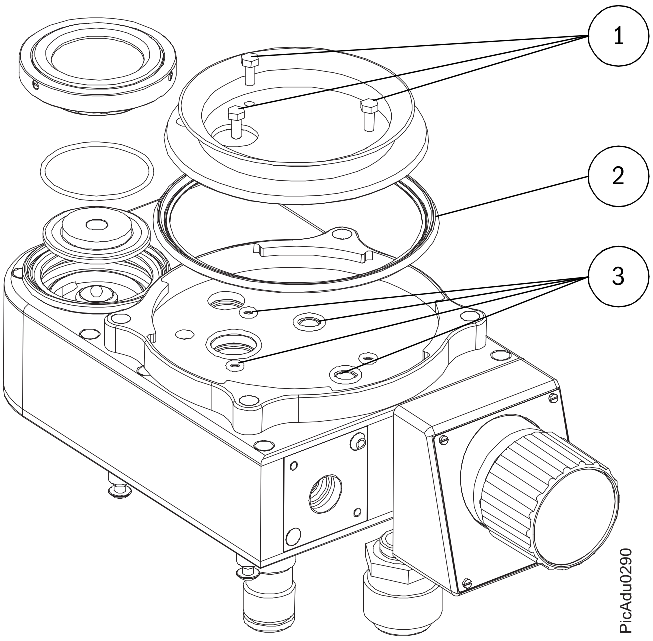


Figure 29 **Exploded view of Bellows block (without chamber)**

Other maintenance

Step 15: Compact Circuit Block, A-CC1 (One year maintenance)

Spare parts: *42-70015-00, 8570069*

Tools: *Included in every kit.*

1. Replace the old parts (1,2,3,4) with the new parts provided in the kit 42-70015-00 as shown below.
2. Replace the valve covers (item 4) with the new ones from kit 8570069 as shown below.

NOTE: The valve cover kit 8570069 is not part of the regular A-CC1 One year maintenance kit, but it is recommended to be replaced once a year.

NOTE: The Plunger kit 42-70019-00 (Item 5) is not included in the One year kit. Replace these parts only as needed.

NOTE: Be careful not to damage the seating surface of the O-rings during removal or reinstallation.

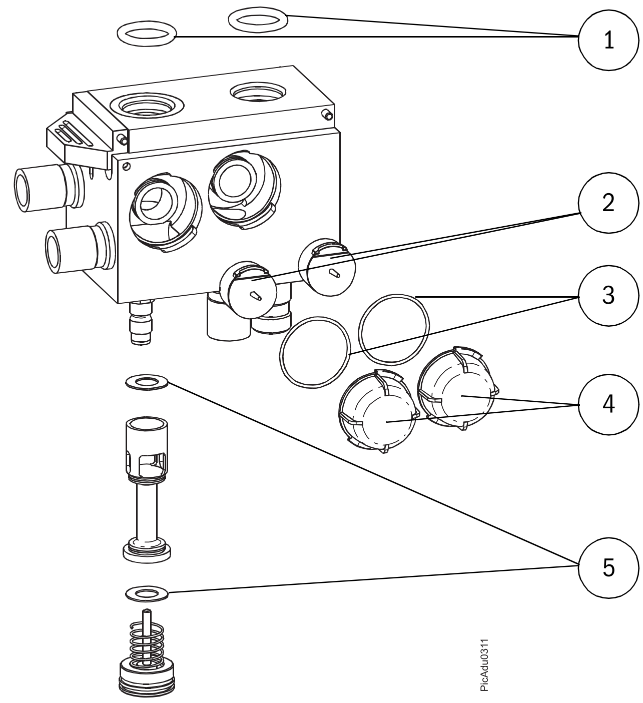

1
2
3
4
5
PicAdu0311

Figure 30 **Compact Circuit A-CC1, exploded view**

Step 16: Compact Circuit Block, A-CC2 (One year maintenance)

Spare parts: *8570071, 8570069*

Tools: *Included in kit.*

1. Exchange the old parts (1 to 9) for the new parts in the kit 8570071 as shown below.
2. Exchange the valve covers (10) with new ones from kit 8570069 as shown below. Note that the valve cover kit 8570069 is not part of the regular A-CC1 one year maintenance kit, but it is recommended to be replaced once a year as a preventive action.

NOTE: Be careful when removing the O-rings so as not do damage their seating surfaces.

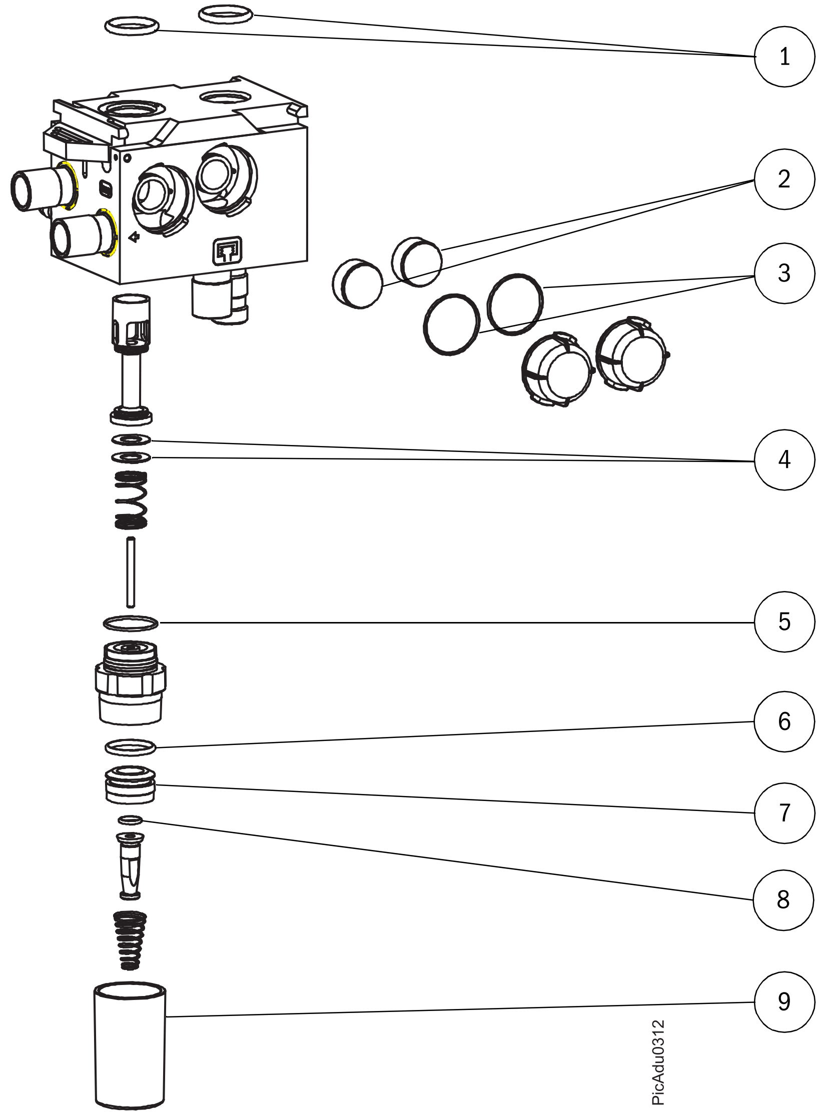


Figure 31 Compact Circuit A-CC2, exploded view

Step 17: O_2 flush (Every 6th year, applies to units with A-WGU-00)

Spare parts: *90700*

Tools: *Allen wrench 4mm*

Cross-head Pozidriv screwdriver

1. Disconnect the gas supply tubing from the wall connectors.
2. Remove the gas bottles from the yokes.
3. Drain the system from gases.
4. Remove the gas supply tubing from the A-WGU.
5. Remove the 10 Allen screws securing the A-WGU to the frame.
6. Remove left side panel and disconnect the A-WGU/A-FGC1 and A-WGU/A-EV1 multiconnectors (including seals) secured by Allen screws (2 each).
7. Carefully remove the A-WGU from the frame.
8. Exchange the old O_2 flush assembly for a new assembly.
9. Reassemble in reversed order.
10. Perform a functional check for the O_2 flush system.

NOTE: Check that seal between the multi-connector and WGU is in the correct position when reinstalling the A-WGU to frame.

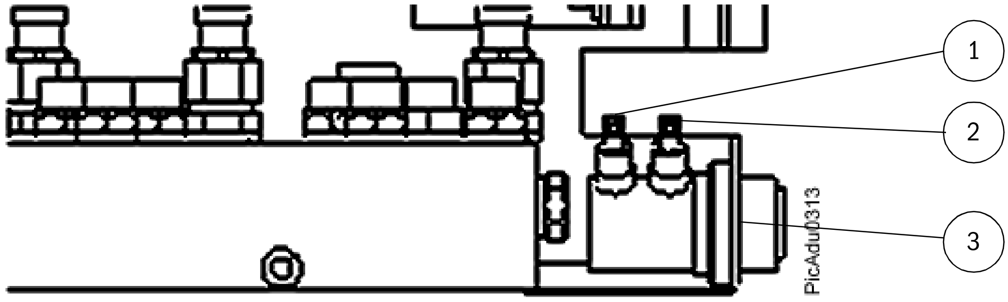


Figure 32 O_2 flush in the Wall Gas Unit

(1) Tube 407

(2) Tube 408

(3) Lock nut

Step 18: O_2 flush kit (Every 6th year. Applies to units with A-WGU-01-02-03 and table mounted O_2 flush)

Maintenance kit:	*8500993 including*
	O-ring 3.1x1.6 mm
	O-ring 9.1x1.6
	O-ring 12.1x1.6 mm
	O-ring 3.3x2.4 mm
Specific tools:	*16 mm wrench*
	PTFE based lubricant

The oxygen flush can be mounted in two different places depending on ADU type:

A)
Frame panel mounted. The oxygen flush is mounted directly onto the connection block in the A-WGU (See picture below)

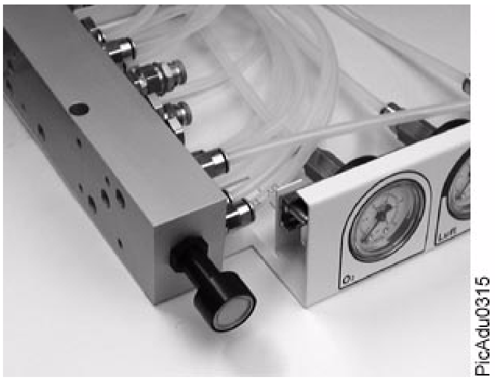


Figure 33 **O_2 flush at frame panel, type A**

B)
Front table mounted. The oxygen flush is mounted in a block underneath the frame table. (See picture below)

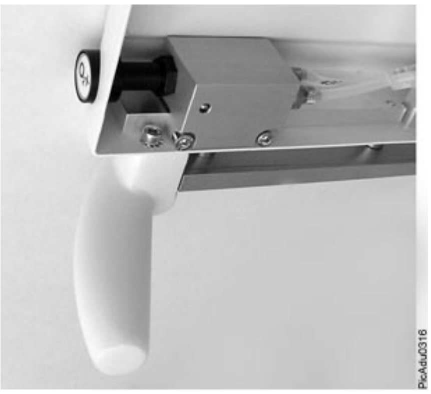


Figure 34 **O_2 flush at front table, type B**

Removal of oxygen flush type A:

1. Disconnect the pipeline gases and close the cylinder valves.
2. Drain the system from gases.
3. Remove the gas supply hose from the A-WGU.
4. Remove the 10 Allen screws securing the A-WGU to the frame.

5. Remove the left side panel and disconnect the A-WGU/A-FGC1 and A-WGU/A-EV1 multi connectors (including seals) secured by Allen screws (2 each).
6. Carefully remove the A-WGU from the frame.
7. Unscrew the O_2 flush assembly from its manifold by using the 16 mm wrench.

Removal of oxygen flush type B:

1. Remove the two Allen screws holding the flush block to table.
2. Disconnect the pipeline gases and; close the cylinder valves.
3. Drain the system from gases.
4. Remove the oxygen flush by using a 16mm wrench.

Replacing of parts and reinstallation of the oxygen flush:

1. Push at (2) and remove O-ring 03-30287-00 from piston (2).
2. Slide out piston (3) and remove O-ring 03-30017-00.
3. Remove the two other O-rings: 03-30097-00 and 03-30067-00.
4. Clean all parts.
5. Apply a thin coat of PTFE based lubricant to the new O-rings.
6. Refit the new O-rings in reverse order to the flush valve.
7. Push the O_2 flush control and check for smooth movement.
8. Reconnect the oxygen flush
9. Perform a Functional Check.

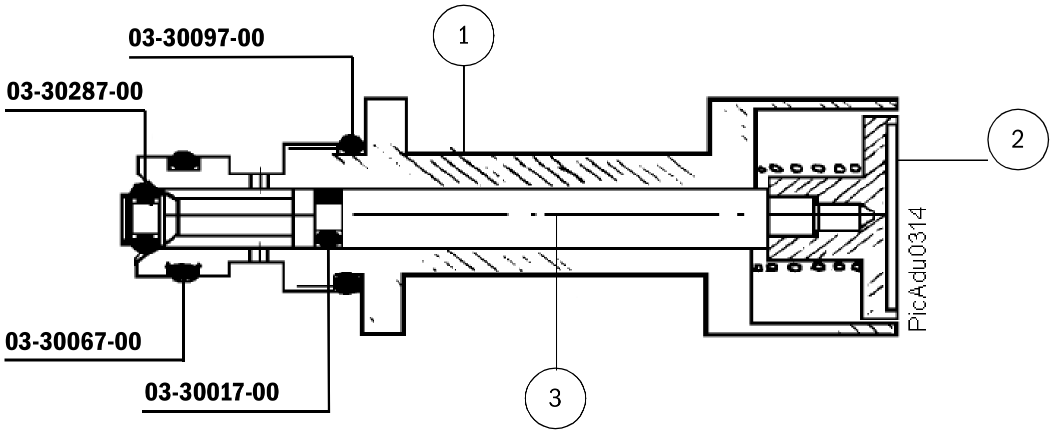


Figure 35 Oxygen flush valve

Step 19: Replacing the Static RAM IC on processor board B-CPU2..01 or B-CPU4..01 Board (every 8th year)

Spare parts: *Static SRAM M48T18 No. 197230*

1. Disconnect the mains power.
2. Remove the CPU board from the Central Electronics module.
3. Replace the Static RAM as in figure below.
4. Reinstall the CPU board and perform a Functional check.

CAUTION During any handling of circuit board make sure that you maintain grounding protection (ESD).

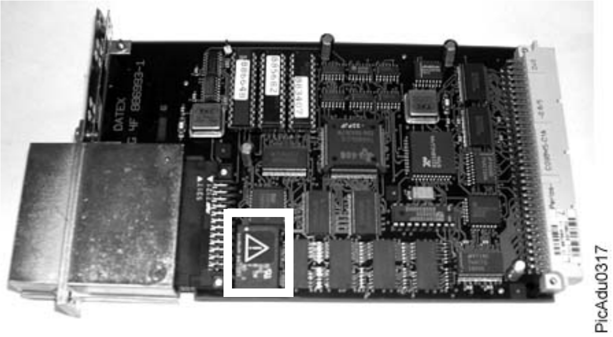


Figure 36 SRAM location B-CPU2

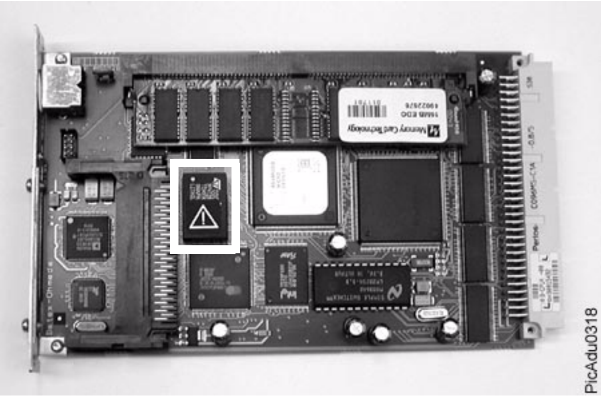


Figure 37 SRAM location B-CPU4

Post-maintenance procedure

1. Reassemble all the panels and any other parts that were removed.
2. Perform a Functional Check.
3. Perform a System Check.
4. Wipe the panels and display clean.
5. Update Maintenance/Service Records.

Kits for maintenance

The numbers in brackets is the quantity of this part in the kit, the order number relates to the individual parts.

NOTE: Parts for maintenance of patient circuits are listed in Datex-Ohmeda Accessories guide.

Contents of One year maintenance kit

Item description **One year maintenance kit**	**Order No.** **893641**
Dust filter	871558
Cassette housing O-rings (2 pcs)	65371
Gas filters (3 pcs: O_2, Air, N_2O)	57142
Gas filter gaskets (3 pcs)	0020068074
Reservoir tube	07-00205-01
APL valve O-ring (2 pcs)	656391
APL valve O-ring	656505
Bellows bottom plate gasket	886394
Overflow valve O-ring	656498
Patient circuit connector O-ring	65374
Fresh gas outlet O-ring	65374
Overflow valve membrane	889112
Gas inlet O-ring (3 pcs)	65399
Manual bag connector O-ring	656507

Contents of Three year maintenance kit

Item description **Three year maintenance kit**	**Order No.** **893642**
Batteries (4 pcs)	891389
Expiration valve membranes (2 pcs)	886432
O-rings for Expiration valve (3pcs)	65363
Chamber seal	886412
O-rings for bellows block (3 pcs)	65394
O-ring for bellows block (2 pcs)	656499
O-ring for bellows block	65389
O-ring Expiration valve housing	050083349

Other maintenance parts

Item description	**Order No.**
One year A-CC1 maintenance kit	42-70015-00
One year A-CC2 maintenance kit	8570071
Valve covers kit A-CC1 and A-CC2 recommends to be replaced once a year	8570069
O_2 flush assembly (every 6th year). For A-WGU-00	90700
O_2 flush maintenance kit (every 6 th year). For A-WGU-01	8500993
Static RAM IC for B-CPU2 (every 8^{th} year)	197230

For other spare parts and maintenance kit, see *"Supplies & Accessories Guide".*

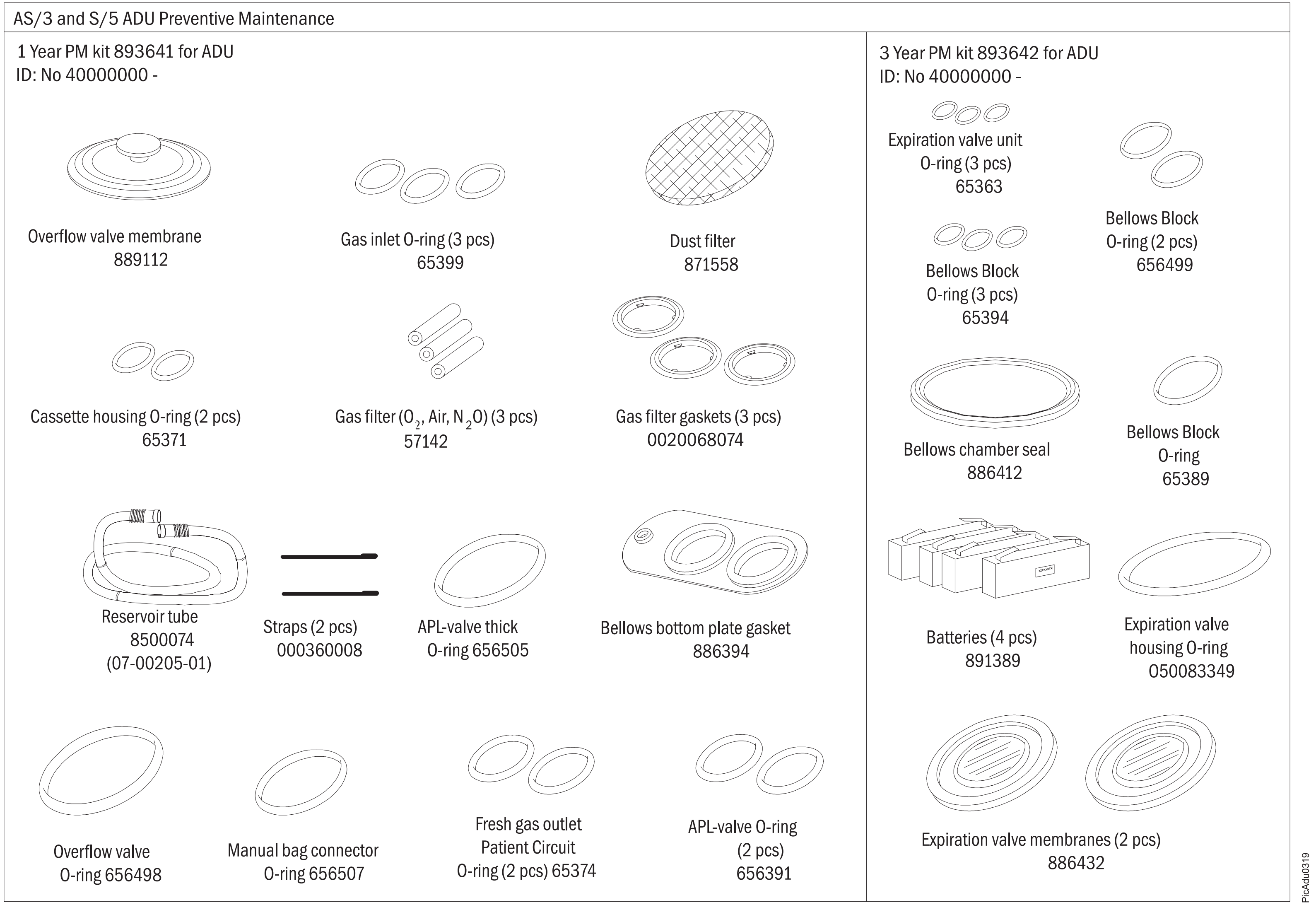

AS/3 and S/5 ADU Preventive Maintenance
1 Year PM kit 893641 for ADU
ID: No 40000000 -
Overflow valve membrane
889112
Gas inlet O-ring (3 pcs)
65399
Dust filter
871558
Cassette housing O-ring (2 pcs)
65371
Gas filter (O2, Air, N2O) (3 pcs)
57142
Gas filter gaskets (3 pcs)
0020068074
Reservoir tube
8500074
(07-00205-01)
Straps (2 pcs)
000360008
APL-valve thick
O-ring 656505
Bellows bottom plate gasket
886394
Overflow valve
O-ring 656498
Manual bag connector
O-ring 656507
Fresh gas outlet
Patient Circuit
O-ring (2 pcs) 65374
APL-valve O-ring
(2 pcs)
656391
3 Year PM kit 893642 for ADU
ID: No 40000000 -
Expiration valve unit
O-ring (3 pcs)
65363
Bellows Block
O-ring (2 pcs)
656499
Bellows Block
O-ring (3 pcs)
65394
Bellows chamber seal
886412
Bellows Block
O-ring
65389
Batteries (4 pcs)
891389
Expiration valve
housing O-ring
050083349
Expiration valve membranes (2 pcs)
886432
PicAdu0319

Figure 38 Maintenance parts

Functional check

Datex-Ohmeda recommends using the check list forms included with this manual.

Test devices

There are many types of flow and pressure test devices available that can be used to complete this procedure. Datex-Ohmeda recommends no specific device. Specifications are provided with this chapter. The flow and pressure test devices should have an accuracy of +/-2.5% or better.

Datex-Ohmeda assumes that technical and biomedical professionals know how to use the device available at his/her institution. Therefore, test device instructions are not included in this manual.

NOTE: If a check does not pass a test, verify that your test devices and setup to the measuring point are correct before starting to calibrate or changing parts.

A Functional Check must be carried out

- After the first installation and after all reinstallations
- Every six months
- After planned maintenance
- After maintenance procedures
- After servicing the ADU
- After storage

NOTE: If the ADU fails any part of the Functional Check, it must not be used in the operating theatre.

Equipment needed for a functional check

- A calibrated test device to measure:
  - High/Low flow
  - High/Low pressure
- Calibrated Gas Monitor (for example Capnomac Ultima, AM with Gas Module or 5330 Monitor)
- Voltmeter
- Aladin, Enflurane or Sevoflurane cassette
- Electrical safety tester
- Test lung 2 liters
- High pressure test adapter, 8500002
- Test Resistance when performing Tidal Volume test, 535335100

Step 0: Preparations

To prepare the monitor and test device for a Functional Check

1. Turn on the gas monitor and the calibrated test device for a warm-up period.
2. Calibrate the monitor with its calibration gas.

To prepare the ADU for a Functional Check

1. Plug the power cord into a mains power supply outlet.
2. Connect the ADU gas inlets to the hospital pipelines.
3. Connect the ADU scavenging outlet to the hospital scavenging system.
4. Connect the ADU vacuum outlet to the hospital vacuum system.

5. Turn on the ADU and push the **Setup** key. Select ***Install*** and enter the distributor password. Select ***Install - User Config - Ambient pressure.*** Select and enter the external air pressure (see the chart below). The first row shows the height above sea level (meters) and the second row shows the atmospheric pressure:

height (m)	0	200	400	600	800	1000	1200	1400	1600
(mbar)	1013	988	964	940	917	894	872	850	829

height (m)	1800	2000	2200	2400	2600	2800	3000	3200	3400
(mbar)	809	789	769	750	732	714	696	679	662

6. To ensure there are no system leaks before proceeding, enter the System Check and carry out the Auto and Manual leak checks.

Frame

Step 1: External Check

For external damages, check:

1. Drawers
2. Wheels and brakes
3. Shelves and other utilities
4. Readable labeling
5. Clean from dirt and dust
6. Clean/exchange the dust filter at the back of the Central Electronics unit. If an auxiliary box is fitted, it must be removed.
7. Check the power supply and other connected cables.

Wall Gas Unit

Step 2: Central inlets

Settings:	*Pipeline supplies connected*
	Flow closed
	ADU off

Check that the pressure gauges in the gas supply inlets show 2.7 - 8 × 100 kPa (39.6 - 118 psi) each.

Step 3: High pressure leakage and non-return valves

Equipment needed:	*Calibrated test device*
	High pressure test adapter
	Wrench
Settings:	*Pipeline supplies disconnected*
	ADU off
Test range:	*0-8 bar (0-118 psi)*

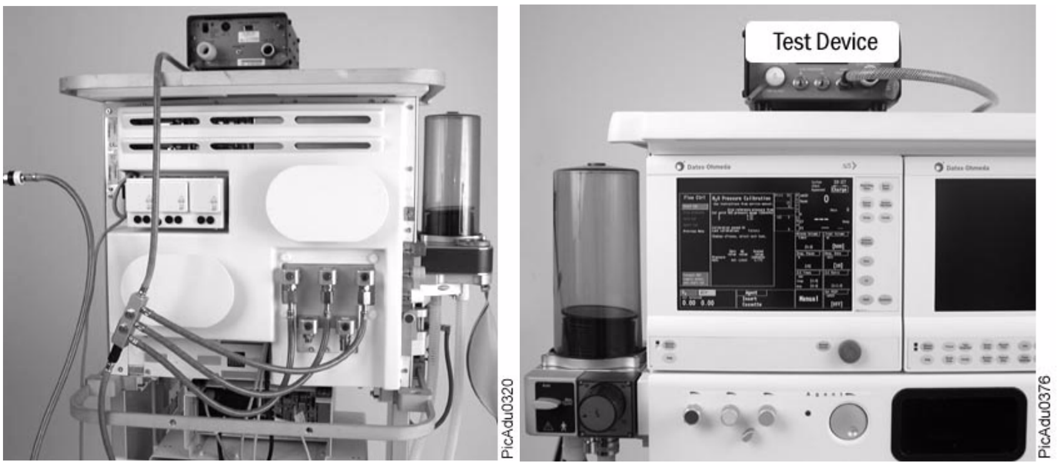


Figure 39 High Pressure Leakage and Non-return Valves test setup

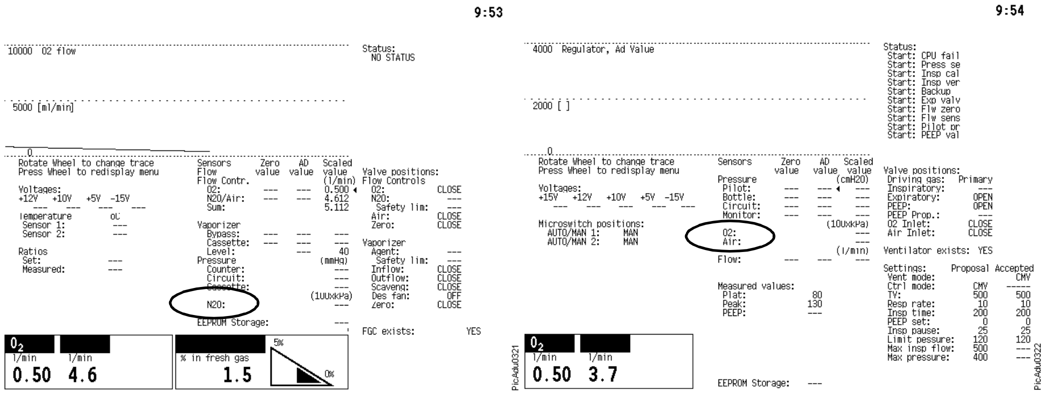
NOTE: Make sure that the inlet gas connection unit on the WGU (wall gas unit) is in its upright position and not hanging down. If so the non- return valves may leak during the test.

1. Disconnect the gas inlet hoses O_2, N_2O and Air from the WGU gas inlets (gently because of the high pressure)
2. Connect the high pressure test adapter and test device as shown in Figure 39 on page 5-33.
3. Close the flow controls. Close A-SEJ2 if installed. Close or disconnect other accessories connected to the external gas outlets to avoid leaks.
4. Turn on the ADU and wait for the self test to be completed.
5. Push the **Setup** key. Select ***Service*** and enter *Diagnostics* or *Calibration Password.*
6. Select ***Diagnostics - Ventilator***
7. Compare the O_2 and air pressure sensor values on the diagnostic page to the test device. Tolerances are 40 kPa (0.4 bar/5.9 psi) for each specific gas.
8. Compare the O_2 and air pressure gauges values to the test device. Tolerances are 40 kPa (0.4 bar/5.9 psi) for each pressure gauge.

9. Select ***Previous menu - Fresh gas control*** and perform step 7 and 8 but for N_2O.

NOTE: If any of the pressure sensors are out of tolerance, they need to be recalibrated. For O_2 and air pressure sensors, please refer to *"Part II"* section *"Electronic Ventilator - Calibration"* in this manual. For the N_2O sensor, refer to *"Part II"* section *"Fresh Gas Control Unit - Calibration"*.

NOTE: If any of the pressure gauges are out of tolerance, the need to be replaced.



```
                                                                  9:53
10000  02 flow                                          Status:
                                                          NO STATUS

5000 [ml/min]

   0
Rotate Wheel to change trace    Sensors      Zero   AD     Scaled
Press Wheel to redisplay menu   Flow         value  value  value    Valve positions:
                                Flow Contr.                (l/min)  Flow Controls
Voltages:                         02:        ---    ---    0.500 ◂   02:          CLOSE
+12V   +10V   +5V  -15V           N20/Air:   ---    ---    4.612     N20:           ---
   ---   ---   ---   ---          Sum:                     5.112      Safety lim:   ---
Temperature         oC                                               Air:         CLOSE
 Sensor 1:          ---         Vaporizer                            Zero:        CLOSE
 Sensor 2:          ---           Bypass:    ---    ---      ---
                                  Cassette:  ---    ---      ---    Vaporizer
Ratios                            Level:            ---       40     Agent:         ---
 Set:               ---         Pressure                   (mmHg)     Safety lim:   ---
 Measured:          ---           Counter:                   ---     Inflow:      CLOSE
                                  Circuit:                   ---     Outflow:     CLOSE
                                  Cassette:                  ---     Scaveng:     CLOSE
                                                        (100xkPa)    Des fan:       OFF
                                  N20:                       ---     Zero:        CLOSE

                                EEPROM Storage:              ---
                                                                    FGC exists:     YES
O2                                 5%
l/min   l/min    % in fresh gas
0.50    4.6           1.5          0%
```

```
                                                                           9:54
4000  Regulator, Ad Value                                   Status:
                                                             Start: CPU fail
                                                             Start: Press se
                                                             Start: Insp cal
                                                             Start: Insp ver
                                                             Start: Backup
2000 [ ]                                                     Start: Exp valv
                                                             Start: Flw zero
                                                             Start: Flw sens
                                                             Start: Pilot pr
                                                             Start: PEEP val
  0
Rotate Wheel to change trace        Sensors   Zero   AD     Scaled
Press Wheel to redisplay menu                 value  value  value   Valve positions:
                                    Pressure               (cmH20)   Driving gas:   Primary
Voltages:                            Pilot:   ---    --- ◂   ---     Inspiratory:       ---
+15V   +12V   +10V   +5V  -15V       Bottle:  ---    ---     ---     Expiratory:       OPEN
   ---    ---    ---   ---   ---     Circuit: ---    ---     ---     PEEP:             OPEN
                                     Monitor: ---    ---     ---     PEEP Prop.:        ---
Microswitch positions:                                 (100xkPa)     02 Inlet:        CLOSE
  AUTO/MAN 1:    MAN                 02:                     ---     Air Inlet:       CLOSE
  AUTO/MAN 2:    MAN                 Air:                    ---
                                                         (l/min)    Ventilator exists:  YES
                                    Flow:     ---    ---     ---
                                                                    Settings:   Proposal Accepted
                                                                     Vent mode:              CMV
                                    Measured values:                 Ctrl mode:       CMV  -----
                                     Plat:           80              TV:              500    500
                                     Peak:          130              Resp rate:        10     10
                                     PEEP:          ---              Insp time:       200    200
                                                                     PEEP set:          0      0
                                                                     Insp pause:       25     25
                                                                     Limit pessure:   120    120
O2                                                                   Max insp flow:   500    ---
l/min   l/min                                                        Max pressure:    400    ---
0.50    3.7
                                    EEPROM Storage:  ---
```

Figure 40 The A-FGC1 and the A-EV1 diagnostic pages

10. Disconnect the test adapter gas inlet from the pipeline supplies gas (Air).
11. Wait one minute for the pressure in the system to stabilize.

NOTE: Make sure that the gas inlet assembly block on the A-WGU is in upward position when performing the test of the non-return valves.

12. Check that the pressure drop on the test device does not exceed the following value during a period of 2 minutes: < 0.07 x 100 kPa. (1 psi).

NOTE: If the check fails, check each gas line individually to find out which gas line is leaking and then correct the failure. The total sum of pressure drop when testing the gaslines separately should not exceed 0.2 x 100 kPa (3 psi) during a period of 2 minutes, which is equal to a pressure drop of 1 psi when all three gas lines are tested at the same time.

13. Disconnect the high pressure test adapter.
14. Note the N_2O pressure sensor value on the diagnostic page.
15. Check that pressure drop on N_2O pressure sensor does not exceed the following value during a 2-minute period: < 0.2 x 100 kPa.

NOTE: If pressure drops more is this an indication of a leaking non-return valve in the WGU.

16. Select the previous menu and select Ventilator diagnostic page, and repeat steps 14 and 15 as above but for O_2 and Air.
17. Connect the gas hoses O_2, N_2O and Air to their respective inlet connections on the WGU.

Step 4: Cylinder pressure and yoke pressure regulators

This check is only intended for ADU with Yokes installed.

Settings: *ADU on*
Pipeline supplies gases disconnected
Flows closed
Gas cylinders disconnected
Manual mode
Air/N_2O switch in N_2O position

To check cylinder pressure, cross connection and tightness:

1. Relieve the system from gas pressure by opening the N_2O flow needle valve fully, the O_2 flow needle valve one turn, and wait for the 'O_2 and N_2O supply pressure lost' alarms to be displayed. Turn the Air/N_2O switch to Air position, open the air flow needle valve fully and wait for the 'Air supply lost' alarm to be displayed.
2. Close flow controls.
3. Push the **Setup** key. Select ***Service*** and enter *Diagnostics* or *Calibration password.*
4. If an N_2O yoke and bottle is being tested select ***Diagnostic -Fresh Gas Control.*** If an O_2 or Air yoke and bottle is being tested select ***Diagnostic -Ventilator.***
5. If more than one O_2 or Air yoke are installed they have to be checked separately.
6. Connect the cylinder to the yoke(s) being checked.
7. Turn on the cylinder pressure and check that the corresponding cylinder pressure gauge indicates:
   O_2 or Air: 0-315 x 100 kPa (0-315 bar / 0-4568 psi)
   N_2O: 0-100 x 100 kPa (0-100 bar / 0-1450 psi).
8. Open a related flow control to 1-2 liters/min.

NOTE: N_2O flow can only be delivered if the O_2 flow control is open. This requires the N_2O/Air switch in N_2O position and O_2 pipline or cylinder pressure reconnected.

9. Check the cylinder and regulated pressures on the relevant diagnostic page and ensure they are within the ranges below. Is according to the table below. If not, adjust the regulator appropriately.

Cylinder pressure		**Adjust O_2/Air reg.**		**Adjust N_2O reg.**	
x 100 kPa	**psi**	**x 100 kPa**	**psi**	**x 100 kPa**	**psi**
20-60	290-870	4-3.8	58-55	3.7-3.5	54-51
60-100	870-1450	3.8-3.5	55-51	3.5-3.2	51-46
100-140	1450-2030	3.5-3.2	51-46	N/A	N/A
140-200	2030-2900	3.2-3.0	46-43	N/A	N/A

NOTE: Be aware that the yoke regulator pressure is dependent on the cylinder pressure: typically the yoke regulated pressure will increase by 1.2x 100kPa (1.2bar / 17.4 psi) as the cylinder pressure fall from 200-20 x100 kPa (200-20 bar / 2900-290 psi).

NOTE: If the yoke regulated pressure (3.5 bar / 51.5 psi) is higher than the central regulated pressure, it is recommended to reduce the yoke pressure below the central pressure, or to increase the central regulated pressure. Otherwise the cylinder gas (if turned on) will be used until it reaches central gas pressure. If reducing the yoke regulated pressure, it is recommended not to go below 3 x100 kPa (3.0 bar / 43.5 psi). If an adjustment is necessary proceed as follows.

10. Close the flow control(s) and turn off the cylinder gas.
11. Repeat the above check for a secondary O_2 or Air yoke with cylinder:
12. Close the cylinder pressure and turn off the ADU.

Step 5: Cross-connections

Equipment needed: *Calibrated gas monitor*
Optional: *D-lite sensor*
Settings: *Pipeline supplies connected to ADU.*

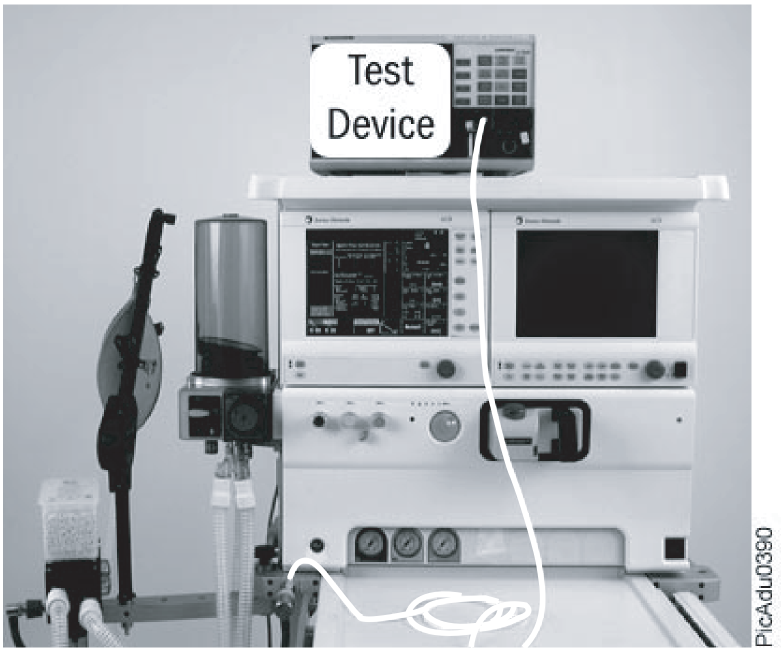


Figure 41 Cross-connections test setup

1. Connect the monitor sampling line between the fresh gas outlet and the fresh gas hose.
2. Turn the N_2O/Air selector switch to the Air position.

3. Open the air flow to approx. 2 l/min. Check that the monitor shows 21 ± 3% O_2 concentration.
4. Close the air flow and open the O_2 flow to approx. 2 l/min. Check that the monitor shows 100 ± 3% O_2 concentration.
5. Turn the N_2O/Air selector switch to the N_2O position.
6. Open the N_2O flow to 2 l/min. Check that the monitor shows 50 ± 3% N_2O concentration and 50 ± 3% O_2 concentration.
7. Close the gas flows. Remove the monitor sampling line from the fresh gas outlet.
8. Option - If there are optional ”quick” gas outlet connectors, the following must be done after servicing the WGU:

A) Disconnect the air pipeline gas and open the Air flow control
to relieve the air pressure. Close the Air flow control.

B) Open the optional air ”quick” gas outlets (with a male connector) and check that there
is no flow. Reconnect the air supply inlet.

C) Disconnect the O_2 Pipeline supplies gas and open the O_2 flow control
to relieve the O_2 pressure. Close the O_2 flow control.

D) Open the optional O_2 ”quick” gas outlets (with male connector) and check that there
is no flow. Reconnect the O_2 supply inlet.

E) Open the optional VAC ”quick” gas outlet and check that the there is vacuum.

Step 6: O_2 flush

O_2 flush releases a high O_2 flow into the patient circuit. The flow is measured by connecting a flow measuring device to the fresh gas outlet.

Equipment needed:	*Calibration test device*
Settings:	*Pipeline supplies gases connected.*
Test range:	*0-60 l/min.*

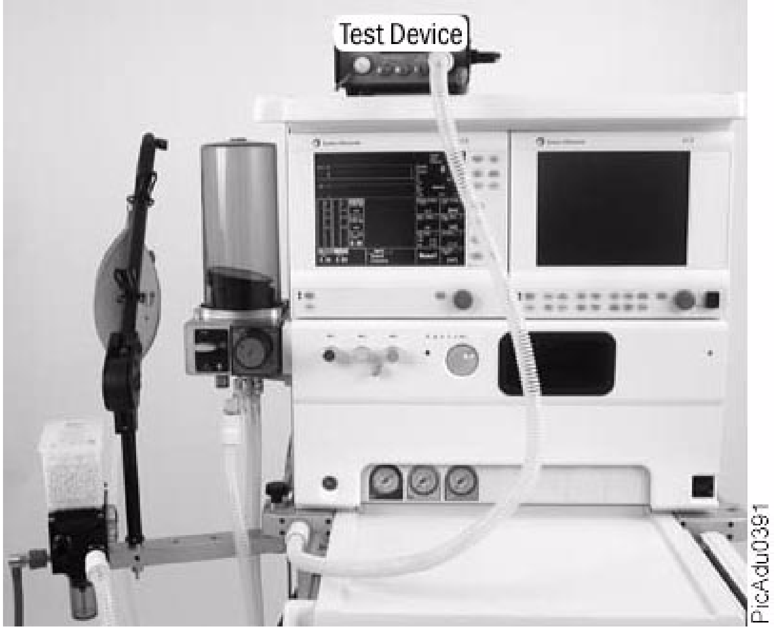


Figure 42 O_2 flush test setup

1. Connect the test device high flow inlet to the fresh gas outlet using the patient circuit tube.
2. Close the O_2 flow and push ”O_2 flush” control. Check that O_2 flow is 25 - 35 l/min. for units with A-WGU-00, and 35-50 l/min. for units with A-WGU-01.

3. Check that the test device does not indicate any flow when the ”O_2 flush” control is released.
4. Disconnect the test device and reconnect the fresh gas hose to the fresh gas outlet.

Step 7: Evacuation outlet

Settings: *Pipeline supplies gases connected*
Evacuation outlet connected
No gas flows

NOTE: If the delivery unit is equipped with an additional scavenging ejector unit, carry out this check with the ejector on.

1. Close the patient circuit and occlude the Y-piece.
2. Open (=1.5 cmH_2O) the APL valve. Check that the patient circuit pressure on the ADU display does not fall below 0 cmH_2O.

Central Electronics

Step 8: Auxiliary mains socket outlets

Equipment needed: *Voltmeter*

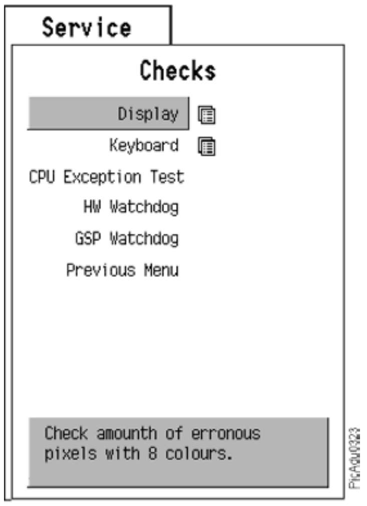
Check all auxiliary outlets for correct voltage.

Step 9: Batteries

Unplug the power cord from the power supply outlet. Check that the message ‘Mains power lost’ is displayed and that the ADU works on battery power for 15 minutes. Meanwhile, continue the Functional Check.

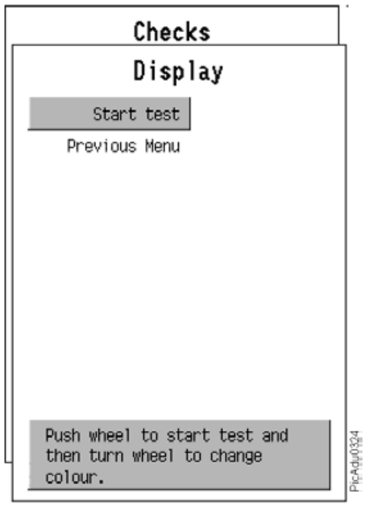
Step 10: Display

1. Push the **Setup** key. Select ***Service*** and enter *Diagnostic* or *Calibration password*.
2. Select ***Checks - Display -Sart test.*** Turn the **ComWheel**. Check that 8 colors are present with no serious pixel errors.
3. Select ***Previous Menu.***


Service
Checks
Display
Keyboard
CPU Exception Test
HW Watchdog
GSP Watchdog
Previous Menu
PicAdu0323

Check amounth of erronous pixels with 8 colours.

Figure 43 **Service - Checks menu**

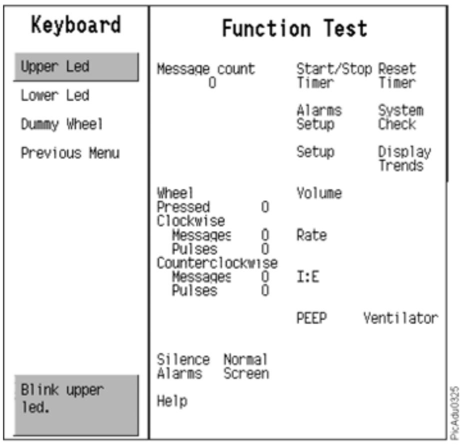

Checks
Display
Start test
Previous Menu
PicAdu0324

Push wheel to start test and then turn wheel to change colour.

Figure 44 **Service - Checks- Display menu**

Step 11: Keyboard

1. Select ***Keyboard*** and push each softkey on the keyboard. Check, when pushing a key, that the corresponding text on the display changes from yellow to red and that there is a beep sound.
2. Select ***Upper LED*** with the **ComWheel**. Check that the upper LED near *Silence Alarm* key lights up.
3. Select ***Lower LED*** with the **ComWheel**. The lower LED near *Silence Alarm* key should light up.
4. Select ***Previous Menu***.


Keyboard
Upper Led
Lower Led
Dummy Wheel
Previous Menu
Blink upper led.
Function Test
Start/Stop Timer
Reset Timer
Alarms Setup
System Check
Setup
Display Trends
Volume
Rate
I:E
PEEP
Ventilator
Silence Alarms
Normal Screen
Help
PicAdu0325

Message count 0

Wheel
Pressed 0
Clockwise
Messages 0
Pulses 0
Counterclockwise
Messages 0
Pulses 0

Figure 45 **Service - Checks - Keyboard menu**

Step 12: Hardware watchdog

Settings: *Manual mode*
Aladin cassette removed
Gas inlets connected to central outlets
ADU on

1. Select ***Checks - HW Watchdog - Start test*** and check that the central electronics is reset and the ADU screen goes blank (may take up to 18 seconds).
2. Check that the Startup screen appears on the display (may take up to 30 seconds) and that, after a few more seconds, the text 'System Failure/Unexpected Reset' appears on the display.

Turn the **On/Standby** switch to the standby position. Wait a few seconds and turn the ADU on again.

Step 13: GSP (Grafix Signal Processor) Watchdog

Settings: *Manual mode*
Aladin cassette removed
ADU on

1. Bypass the System Check and push the **Setup** key. Select ***Service*** and enter the *Diagnostic* or *Calibration password*.
2. Select ***Checks - GSP Watchdog -Start test*** and check that the central electronics is reset and that the ADU screen goes blank (may take up to 18 seconds).
3. Check that the Startup screen appears on the display (may take up to 30 seconds) and that, after a few more seconds, the text 'System Failure/Unexpected Reset' appears on the display.
4. Turn the **On/Standby** switch to the standby position. Wait a few seconds and turn the unit on again.

Fresh Gas Control Unit

Step 14: Fresh Gas Leakage

Equipment:	*Calibration test device and fittings*
Settings:	*The N_2O/Air switch in N_2O position*
	Pipeline supplies gases connected
	No Aladin cassette connected
Test range:	*35-60 cm H_2O*

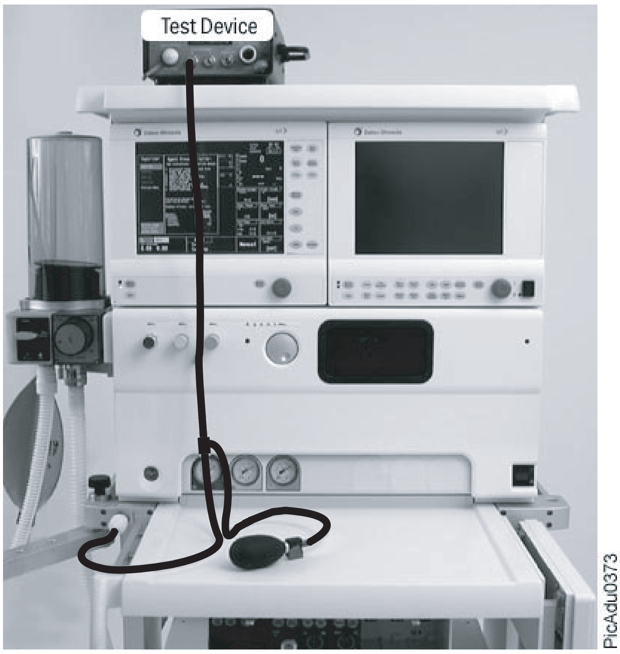


Figure 46 Fresh Gas Leakage test setup

1. Select low pressure range on test device.
2. Carefully adjust the flow controls so that the test device shows approx. a 50 cmH_2O pressure. Close the flows.
3. The pressure should not drop more than 10 cmH_2O in 30 seconds. This corresponds to a leakage of approx. 5 ml/min.
4. Repeat steps 1-3 with the N_2O/Air switch in Air position.

NOTE: If the pressure increases it is an indication of a leaking needle valve.

Step 15: Gas flow controls

Equipment needed:	*Calibrated test device*
Settings:	*Pipeline supplies gases connected*
Test range:	*0-15 l/min. (for flows less than 5 l/min. the tester should be setup to read hundreths (Two digits to the right of the decimal).*

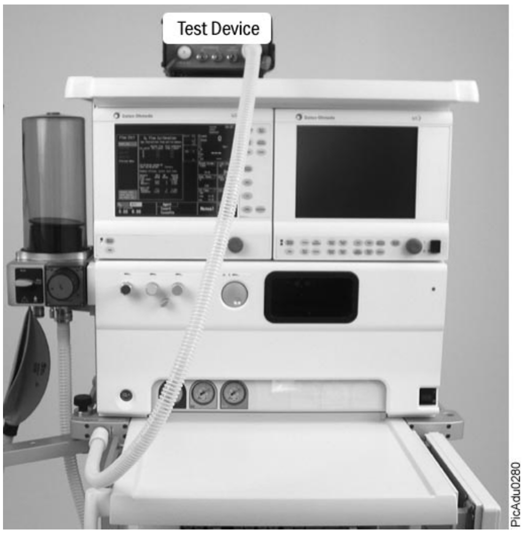


Figure 47 Setup for flows over 5 l/min.

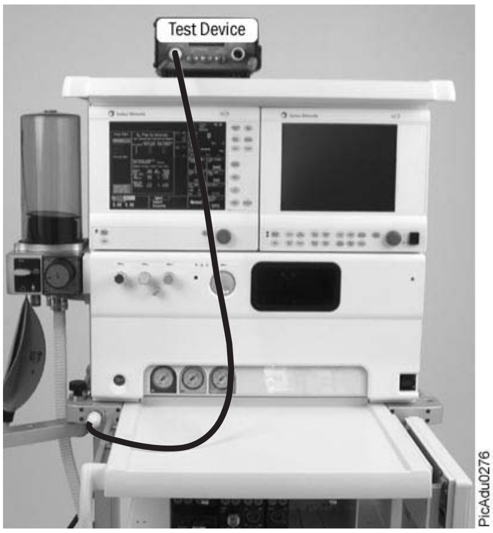


Figure 48 Setup for flows less than 5 l/min.

NOTE: Check that the Ambient Pressure setup in the install menu is correctly done before this check is performed.

1. Remove the fresh gas hose from the fresh gas outlet. Connect the test device to the fresh gas outlet (setup for O_2 flow measurement).
2. Check that all the flow controls can be moved freely.
3. Open the O_2 flow so that the ADU display shows 0.6 l/min. Check that the flow value on the test device is between 0.54 and 0.66 l/min. Check other O_2 flow measurements using the table values below:

Set ADU display reading	Expected Test Device reading
0.6 l/min.	0.54 - 0.66 l/min.
2.0 l/min.	1.8 - 2.2 l/min.
7.0 l/min.	6.3 - 7.7 l/min.
10.0 l/min.	9.0 - 11.0 l/min.

4. Repeat the procedure with the test device set to air flow measurement.
5. Close the gas flows and disconnect the test equipment.

Step 16: Fan cassette check

Equipment needed:	*None*
Settings:	*ADU on*

1. Push the **Setup** key. Select ***Service*** and enter the *Diagnostic* or *Calibration password.*
2. Select ***Diagnostics - Fresh Gas control - Vaporizer Controls - Oper Desflur. - Fan - On.***

3. Check that the fan works by cautiously inserting one hand into the cassette housing to feel the airflow.

Turn the **On/Standby** switch to Standby position to leave the ***Service*** Menu and turn it on again. Select ***Bypass Check- Normal screen*** and Confirm.

Step 17: Fresh gas outlet safety valve

Equipment needed:	*Calibrated test device*
Settings:	*Pipeline supplies gases connected*
Test Range:	*0-150 cm* H_2O

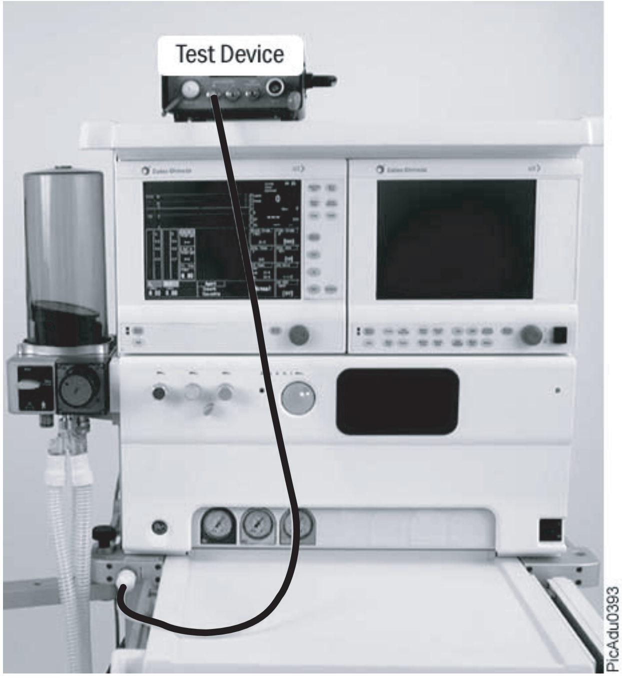


Figure 49 Fresh Gas Outlet Safety Valve test setup

1. Select the relevant low pressure range on the test device and connect a tube from the test device inlet to the fresh gas outlet on the ADU.
2. Adjust the total flow to 10 l/min. Check that the test device shows 80 - 100 cmH_2O.
3. Close the flows, disconnect the test device and reconnect the fresh gas hose to the fresh gas outlet.

Step 18: N_2O / O_2 ratio control

The N_2O/O_2 ratio control limits the N_2O flow to a maximum of 75% of the total flow. This assures a minimum O_2 concentration of 25%.

Equipment needed:	*Calibrated gas monitor*
Settings:	*Pipeline supplies gases connected.*
	Manual mode and APL valve in open position (=1.5 cmH_2O)
	N_2O/Air switch in N_2O position.
Test range:	*0-100%*

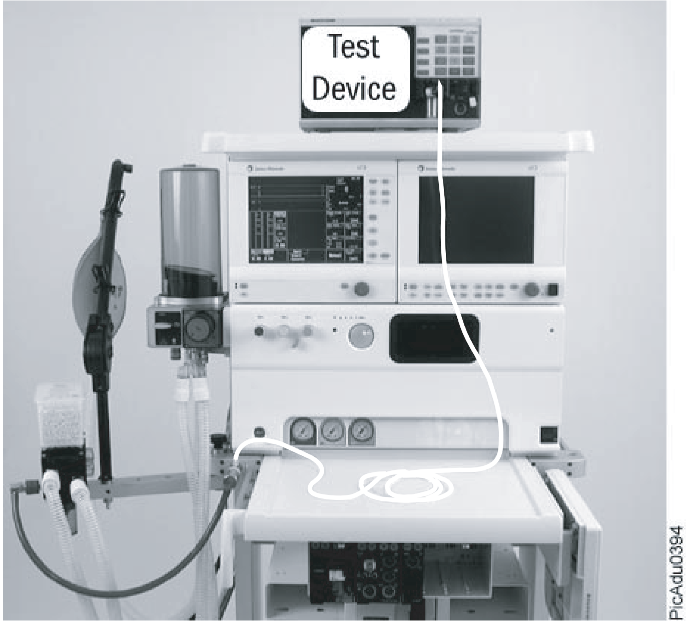


Figure 50 N_2O / O2 Ratio Control test setup

1. Connect the monitor sampling line between the fresh gas outlet and the fresh gas hose.
2. Open the O_2 flow with the flow control and turn the N_2O flow control to fully open. Adjust the O_2 flow to the values listed below.

ADU O_2 flow setting (l/min.)	3.0	2.0	1.0	0.5
Test device measured O_2 conc. (%)	22 - 28	22 - 28	22 - 28	22 - 28

3. Turn the O_2 flow slowly to zero. Check that the N_2O flow falls to zero when the O_2 flow goes below 0.10 l/min.
4. Open O_2 flow to approximately 1 l/min.
5. Disconnect the N_2O pipeline supply gas and check that the alarm 'N_2O Supply lost' is initiated and that the Air gas is automatically selected.
6. Reconnect the N_2O Pipeline supply turn the N_2O/Air switch to Air and then back to N_2O. Verify that the N_2O flow is returning.
7. Close the flows.

Step 19: Agent control check

Equipment needed:	*Calibrated Gas monitor.*
	(Use QUICK CAL™ Calibration Gas, 755582 for the Capnomac Ultima or the AM)
	Filled Enflurane or Sevoflurane Aladin cassette
Settings:	*Test lung connected*
	Pipeline supplies gases connected.
	Scavenging system connected
	Monitor sampling line connected between fresh gas outlet and fresh gas hose
	Manual mode and APL valve set to open position
Test range:	*0-10%*

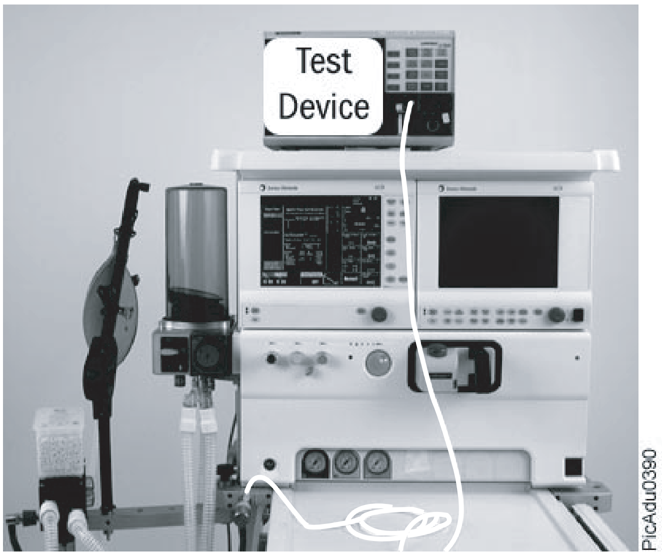


Figure 51 Agent control check setup

NOTE: Connect a tube between the monitor sample outlet and the bellows block scavenging port to avoid contamination of the room.

NOTE: Check that the Ambient Pressure setup is correct before the check is performed. See section *"Functional check, Step 0"* previous in this chapter for detailed instruction.

1. Insert the agent cassette into the slot.

   Capnomac Ultima:
   If there is no agent identification option available in the monitor, push **Select Agent** key and select the agent.

   S/5 or AS/3 AM:
   Push the **Airway gas** key. Push AGENT and select the agent.

NOTE: Typical accuracy for the Capnomac Ultima and AS/3, S/5 AM is ± 0.2 AA%. This is not observed in this section.

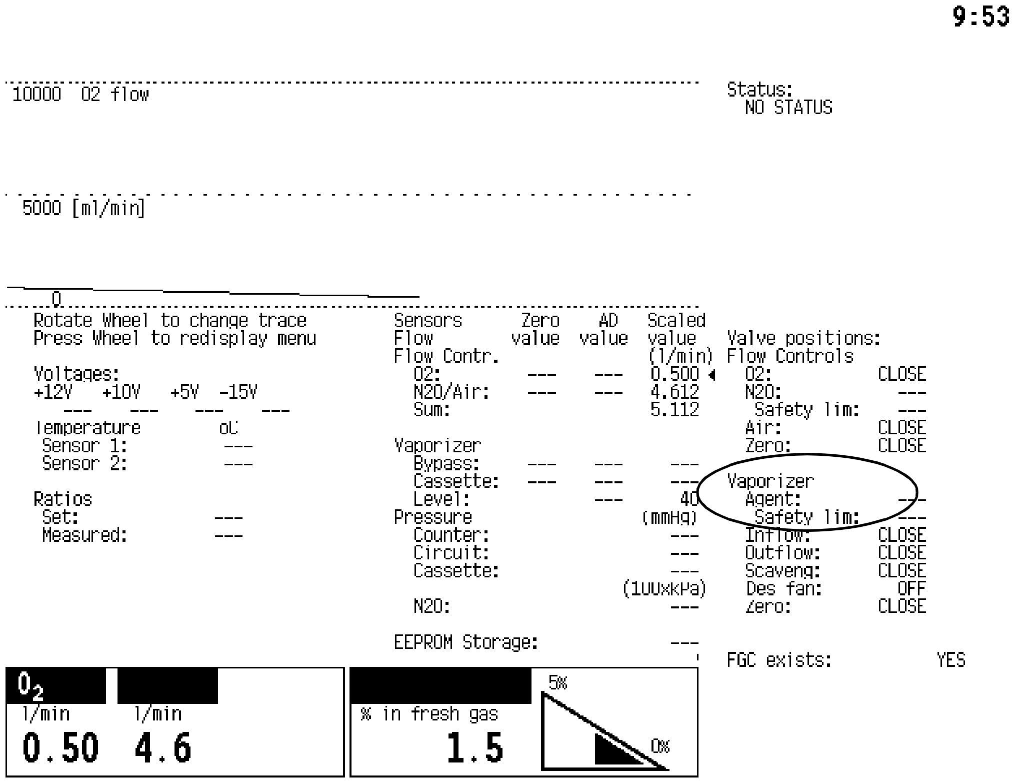
2. Push the **Setup** key. Select ***Service*** and enter *Diagnostic* or *Calibration Password*. Select ***Diagnostics - Fresh Gas Control***.

3. Following the chart below, set O_2 to 1 l/min. and 8 l/min. respectively and select 0.5%, 3.0% and 5.0% agent by turning the **Agent wheel**. Close all other flows. Verify the AA% for each setting and observe the checks later in this section. Let the system stabilize for 1 minute after each agent selection. Also check that the agent LED works.

AA% at sea level ambient pressure		
Agent%	**Flow 1 l/min.**	**Flow 8 l/min.**
0.5	0.35 - 0.65 AA%	0.35 - 0.65 AA%
3.0	2.7 - 3.3 AA%	2.7 - 3.3 AA%
5.0	4.5 - 5.5 AA%	4.5 - 5.5 AA%

At the same time, using the diagnostic page below, check the difference between the *safety limit* and the *Agent* (position of the vaporizer proportional valve) to ensure that the safety limit has been properly calibrated. At 8 l/min. flow and 5% Enflurane or Sevoflurane, the difference should be more than 800. If not, the agent delivery must be recalibrated.

If Sevoflurane is used increase AA settings to 8% and verify that the agent value not reaches the safety limit. If that happens, the calibration must be performed again.



```
                                                                          9:53

 10000  02 flow                                                   Status:
                                                                    NO STATUS

  5000 [ml/min]

       0
    Rotate Wheel to change trace        Sensors      Zero   AD    Scaled
    Press Wheel to redisplay menu       Flow         value  value value     Valve positions:
                                        Flow Contr.               (l/min)  Flow Controls
    Voltages:                             02:          ---    ---  0.500 ◂   02:            CLOSE
    +12V   +10V   +5V  -15V               N20/Air:     ---    ---  4.612     N20:             ---
      ---    ---    ---    ---            Sum:                     5.112      Safety lim:     ---
    Temperature         oC                                                   Air:           CLOSE
     Sensor 1:           ---            Vaporizer                            Zero:          CLOSE
     Sensor 2:           ---              Bypass:      ---    ---    ---
                                          Cassette:    ---    ---    ---   Vaporizer
    Ratios                                Level:              ---     40     Agent:           ---
     Set:               ---             Pressure                  (mmHg)      Safety lim:     ---
     Measured:          ---               Counter:                   ---     Inflow:        CLOSE
                                          Circuit:                   ---     Outflow:       CLOSE
                                          Cassette:                  ---     Scaveng:       CLOSE
                                                                (100xkPa)    Des fan:         OFF
                                          N20:                       ---     Zero:          CLOSE

                                        EEPROM Storage:              ---   FGC exists:          YES

  02
  l/min     l/min                   % in fresh gas
  0.50      4.6                          1.5
```

Figure 52 Fresh Gas Control Unit Diagnostic page

NOTE: The ADU vaporizer performs as an ordinary concentration calibrated vaporizer regarding the effects of varying ambient pressure. The nominal agent volume % setting is graduated at sea level ambient pressure (760 mmHg). If the vaporizer is used at higher altitudes (decreased ambient pressure), the delivered agent volume % will be higher than the set agent volume % in relation to the decrease of the ambient pressure. This is due to the agent partial pressure being independent of the ambient pressure. Therefore the values in the table “AA% at sea level ambient pressure” above are only valid at sea level ambient pressure.

In a different situation, e.g. if the external air pressure is not 1013 mbar (760 mmHg), the solution is to calculate an AA% factor. The formula for the AA% factor is:

$$\frac{\text{sea level ambient pressure}}{\text{ambient pressure}} = \text{factor}$$

Example: A situation where the external pressure is 850 mbar (see chart below, where the first row shows the height above sea level (meters), the second row shows the atmospheric pressure (mbar) and the third row shows the AA% factor.)

Height (m)	0	200	400	600	800	1000	1200	1400	1600
(mbar)	1013	988	964	940	917	894	872	850	829
factor	1	1.0253	1.0508	1.0777	1.1047	1.1331	1.1617	1.1918	1.2220

Height (m)	1800	2000	2200	2400	2600	2800	3000	3200	3400
(mbar)	809	789	769	750	732	714	696	679	662
factor	1.2522	1.2839	1.3173	1.3057	1.3839	1.4188	1.4555	1.4919	1.5302

$$\frac{1013\ \text{mbar}}{850\ \text{mbar}} = 1{,}1918$$

As the AA% factor here is 1.1918, the values for AA% in table “AA% at sea level ambient pressure” must be multiplied by this factor. Results for an 850 mbar external pressure are as follows:

AA% at 850 mbar external pressure		
Agent %	**Flow 1 l/min.**	**Flow 8 l/min.**
0.5	0.42- 0.77 AA%	0.42- 0.77 AA%
3.0	3.2 - 3.9 AA%	3.2 - 3.9 AA%
5.0	5.4 - 6.6 AA%	5.4 - 6.6 AA%

4. Check that the monitor shows the correct agent values.
5. Turn the **Agent wheel** to OFF.
6. O_2 flush the circuit.
7. Close the flow.
8. Disconnect the monitor sampling line and reconnect the fresh gas hose to the fresh gas outlet.
9. Turn the **On/Standby** switch to the standby position.

Step 20: Aladin Cassettes

Settings: *ADU on*
Pipeline supplies gases connected

1. For units equipped with an Aladin cassette for Desflurane: With the cassette inserted and locked in its proper position, check that the liquid level indicator on the display works.
2. For Aladin cassettes with Key filler:check that the gasket is well seated.
3. Perform Agent delivery test with all available Aladin cassettes.

NOTE: That can be done at the end of the Functional check.

Electronic Ventilator

Step 21: O_2 and Air alarm

Settings: *ADU on*
Pipeline supplies gases connected
Flow controls closed
N_2O / Air selector switch in position Air
Reserve gas cylinders off

1. Disconnect the pipeline supply gases O_2 and Air.
2. Open the O_2 and air flow to approximately 3 l/min. Check that an audible and visible 'O_2 Supply Pressure' and 'Air Supply Pressure' lost alarm starts when gases are drained from the ADU.
3. Close the flows and reconnect the O_2 and Air pipeline supply gases.

Step 22: Circuit pressure measurement

Equipment needed:	*Calibrated test device*
Settings:	*ADU on*
	Manual mode
	Y-piece connected to ADU occluder cone on bellows block
	Pipeline supplies gases connected
Test range:	*0-50 cmH_2O*

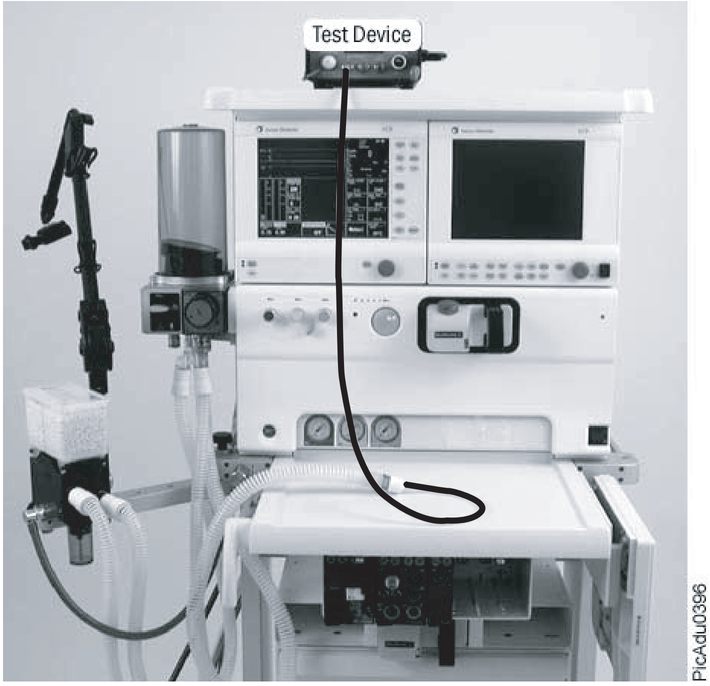


Figure 53 Circuit pressure measurement test setup

1. Enter the relevant range on the test device.
2. Remove the manual bag from its connector and connect a tube between the connector and the low pressure inlet *P+* of the test device.
3. Turn the APL valve to its minimum position (1.5 cmH_2O).
4. Open and adjust one of the flow controls until a total fresh gas flow of 0.5 l/min. is indicated.
5. Adjust the APL valve until the test device indicates a pressure of 30 cmH_2O.
6. Check that the circuit pressure indicated on the ADU display does not differ from the test device reading by more than ±2 cmH_2O.
7. Close the flow and reconnect the manual bag to its connector.

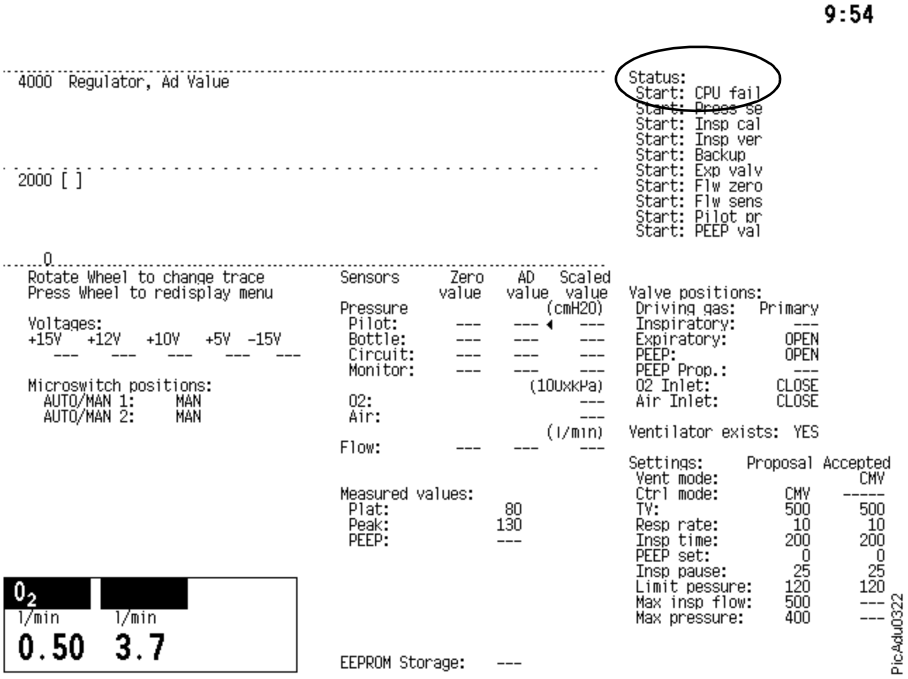
Step 23: Pilot valve pressure

Equipment needed: *None*

Settings: *ADU on*

Pipeline supplies gases connected

1. Push the **Setup** key. Select ***Service*** menu and enter the *Diagnostics or Calibration Password*. Select ***Diagnostics - Ventilator***



```
                                                              9:54

 4000  Regulator, Ad Value                                Status:
                                                           Start: CPU fail
                                                           Start: Press se
                                                           Start: Insp cal
                                                           Start: Insp ver
                                                           Start: Backup
 2000 [ ]                                                  Start: Exp valv
                                                           Start: Flw zero
                                                           Start: Flw sens
                                                           Start: Pilot pr
                                                           Start: PEEP val
     0
   Rotate Wheel to change trace     Sensors     Zero    AD   Scaled
   Press Wheel to redisplay menu               value  value  value   Valve positions:
                                    Pressure               (cmH2O)    Driving gas:   Primary
   Voltages:                         Pilot:     ---    --- ◂  ---     Inspiratory:       ---
   +15V   +12V   +10V   +5V  -15V    Bottle:    ---    ---    ---     Expiratory:       OPEN
      ---    ---    ---    ---   ---  Circuit:   ---    ---    ---     PEEP:             OPEN
                                     Monitor:   ---    ---    ---     PEEP Prop.:        ---
   Microswitch positions:                                (10UxkPa)    O2 Inlet:        CLOSE
     AUTO/MAN 1:     MAN             O2:                        ---   Air Inlet:       CLOSE
     AUTO/MAN 2:     MAN             Air:                       ---
                                                          (l/min)   Ventilator exists:  YES
                                    Flow:       ---    ---    ---
                                                                    Settings:     Proposal Accepted
                                                                     Vent mode:               CMV
                                    Measured values:                 Ctrl mode:       CMV   -----
                                     Plat:             80            TV:              500     500
                                     Peak:            130            Resp rate:        10      10
                                     PEEP:            ---            Insp time:       200     200
                                                                     PEEP set:          0       0
 O2                                                                  Insp pause:       25      25
 l/min     l/min                                                     Limit pessure:   120     120
 0.50      3.7                                                       Max insp flow:   500     ---
                                    EEPROM Storage:   ---            Max pressure:    400     ---
```

PicAdu0322

Figure 54 Diagnostic page A-EV1

2. Check if the 'Pilot press err' status message is present in the status field of the diagnostic page.
3. If there is no such message, then the pilot pressure is OK and no further checks are needed. Proceed to the next functional check.

NOTE: The pilot pressure is checked during the self test procedure, starting when the ADU is switched on. If the pressure is outside its limits, the status message 'Pilot press err' appears on the A-EV1 diagnostic menu.

NOTE: The status message 'Pilot press err' can mean either a too low or too high pressure.

4. Go to the "*Calibration"* section, *Ventilator*, and follow the Ventilator calibration instructions, the Pilot pressure regulator adjustment and, PEEP calibration, before proceeding to the next functional check.

Step 24: Delivered tidal volume

Equipment needed:	*Calibrated test device*
	Test resistance, 535335100
Settings:	*Manual mode*
	Pipeline supplies gases connected
Test range:	*0-1500 ml*

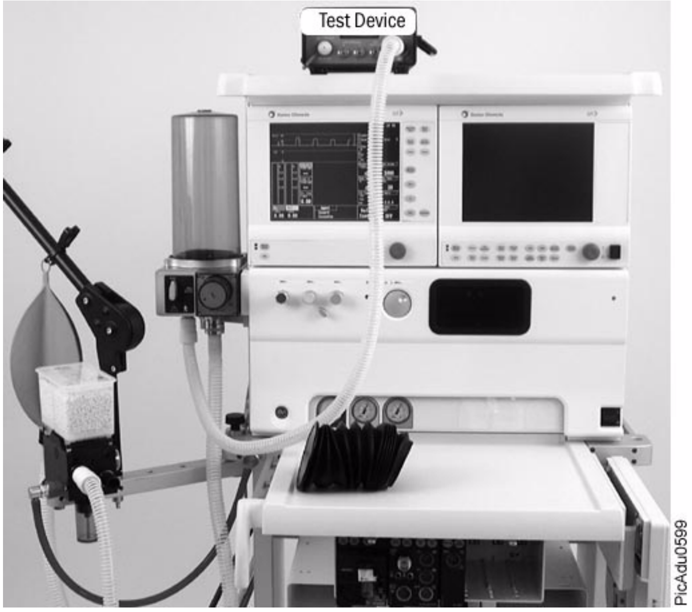


Figure 55 Delivered tidal volume test setup

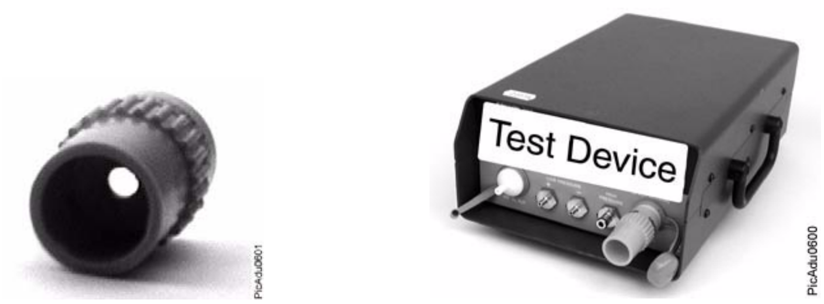


Figure 56 Test resistence Test device

This test procedure is written for a flow-based test device, meaning that the inspiration flow from the ventilator is leaving the test device on its outlet port to the atmosphere. A test resistance (hole between 4 - 6 mm.) is also needed to avoid unnecessary triggering of the ‘Fill bellows alarm’ during the testing.

1. Push the **System check** button and select ***Auto ventilation***. Confirm by pushing the **ComWheel** and carry out the check. Make sure that this check passes before proceeding to the next step.
2. Turn to the manual mode, remove the bellows and refit the bellows chamber to the bellows block.
3. Connect the test resistance to the flow measurement test device inlet port and select O_2 or Air on the test device depending on if the Ventilator is O_2 or Air driven (this can be checked in the Setup Install menu on ADU).

4. Connect a leak free hose between the bellows block circuit connection and the resistance attached to the test device.
5. Select the following parameter values for the Ventilator:

Volume	1000
Rate	6
I:E	1:2.0
Insp.Pause	25

6. Turn the Auto/Man. switch to Auto mode. Let the ventilator operate for one minute.
7. Read the delivered tidal volume on the test device. Check that the tidal volume is 900 - 1100 ml/min. (0.90 - 1.10 on the test device).
8. Turn Auto/Man. switch to Man. position.
9. Select the following parameter values

Volume	200
Rate	20

10. Turn the Auto/Man. switch to the Auto position. Let the ventilator operate for one minute.
11. Read the delivered tidal volume on the test device. Check that the tidal volume is 180 - 220 ml/min. (0.18 - 0.22) on the test device.
12. Turn the Auto/Man. switch to the Man. position.
13. Disconnect the test device and refit the bellows and circuit hoses.

Step 25: Driving gas selecting unit

There are two ventilator driving gas sources, primary (Air/O_2) and secondary (O_2/Air). If the pressure of the primary gas is lower than 2.5 bar, the driving gas selecting unit automatically switches over to the secondary gas source.

Settings: *Auto mode*
Test lung connected
Pipeline supplies gases connected

1. Check that the delivery unit uses its primary gas as the driving gas. The pressure gauge of the primary gas oscillates slightly at the rate of the ventilator.
2. Disconnect the primary gas central inlet from the central outlet. Check that the ventilator does not stop, but switches to the secondary gas for driving. The pressure gauge of the secondary gas oscillates slightly at the rate of the ventilator and the alarm ‘Driving gas to secondary’ appears.
3. Disconnect the secondary gas supply inlet from the wall outlet. Check that the ventilation stops and the alarms ‘Ppeak Low’ and ‘Cannot deliver set vol.’ appear after a few seconds.
4. Reconnect the secondary gas supply inlet to the central outlet. Check that ventilation starts and the alarms (‘Ppeak Low’ ‘Cannot deliver set vol.’) disappear.
5. Reconnect the primary gas supply inlet to the central outlet. Check that the alarm ‘Driving gas to secondary’ disappears.

Step 26: PEEP function test

Equipment needed: *Test lungs*

Settings: *ADU on*

Pipeline supplies gases connected

Manual mode

Patient circuit and a 2 L test lung connected to the Y-piece

1. Connect a 2 l test lung to the Y-piece.
2. Set the fresh gas air flow to 1 l/min.
3. Select the following ventilator settings:

Volume	200
Rate	8
I:E	1:2.0
Insp. Pause	25

4. Turn the switch to Auto ventilation.
5. Change PEEP settings successively to: OFF, 5 and 15 cmH_2O and read the values measured by the ADU. After each PEEP setting, check on the screen graph that the required PEEP level is reached and is stable.

Tolerances: For OFF position = Max 4 cmH_2O.

Tolerances: PEEP setting up to 20 cmH_2O = ± 2 cmH_2O.

NOTE: For too high a PEEP in the OFF position, explore the overflow membrane.

Step 27: PCV check

Settings: *Manual mode*

ADU on

Pipeline supplies gases connected

Patient circuit and a 2 l test lung connected to the Y-piece

1. From the Ventilator setup, select PCV mode and set the following parameter values:

Pressure	20 cmH_2O
Resp.Rate	20
I:E Ratio	1:1.0
PEEP	OFF

2. Turn to Auto mode.
3. Adjust the fresh gas flow to 1 l/min. and keep it there until the inspired pressure has settled.
4. Check that no pressure alarm occur.
5. Check on the pressure curve that the peak plateau pressure, 20 cmH_2O plus actual PEEP is stable within ± 2 cmH_2O.

Electrical safety

Step 28: Electrical safety test

Equipment needed: *Electrical safety tester*

The ADU is classified as Class I, Type B according to IEC 60601-1.

Tests recommended to perform once a year are:

- Protective earth resistance (see measuring points below)
- Insulation resistance
- Earth leakage current

NOTE: Equipment connected to the ADU needs to be checked in accordance with their respective classifications.
Local routine checks regarding electrical safety also have to be considered.
Auxiliary monitoring devices are classified separately and may have other classifications.

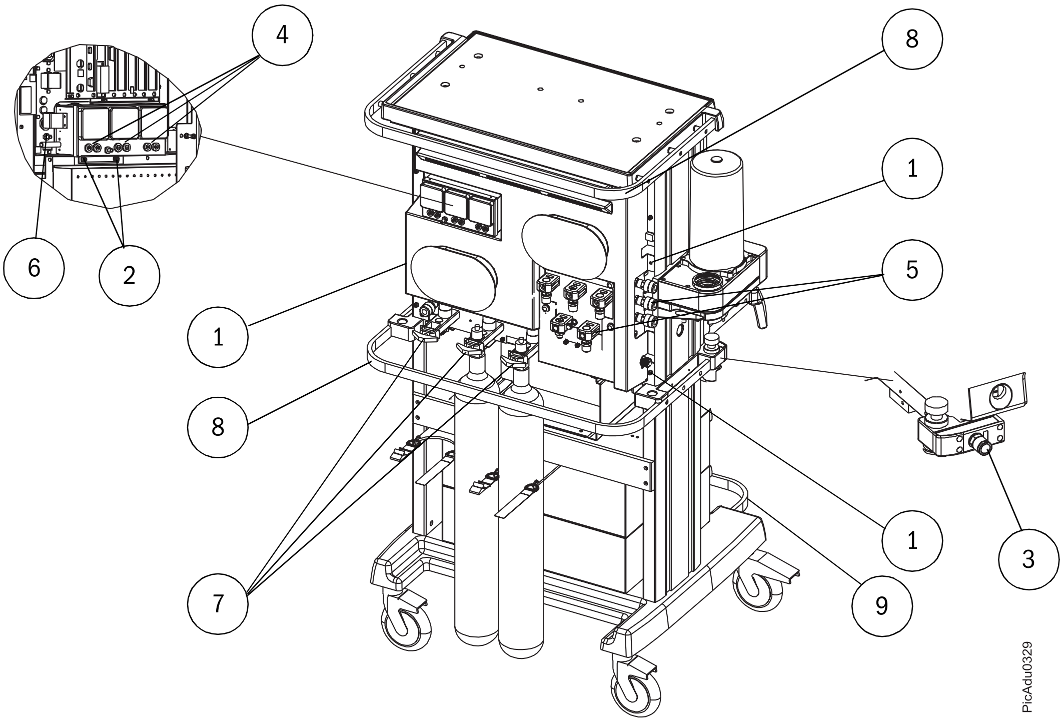


Figure 57 Measuring points for protective earth resistance

(1) Panel fastening screws. Apply the probe on the screws with toothed washer (x3).
(2) Auxiliary mains outlet box fastening screw
(3) Fresh gas outlet
(4) Auxiliary mains outlet box ground sockets
(5) Gas inlets and outlets
(6) Protected ground connectors
(7) Yokes
(8) Accessory rails
(9) Footrest

NOTE: If anodized aluminum parts are to be tested; make sure to get through the surface by using a sharp contact point where the contact mark does not show.

System check

Step 29: System check

Push the **System check** button and carry out the ***Full check*** as described in the *“User’s Reference Manual”*.

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6 TECHNICAL SPECIFICATIONS

General

Specifications valid for ADU ID: 40 000 000 and greater

Dimensions

Basic unit with cart	
Height	Two optional heights: 1410 / 1540 mm
Display viewing level	1242 / 1372 mm
Depth	780 mm
Width	840 mm
Floor space	705 mm x 726 mm
Weight	112 - 130 kg

Basic unit without cart	
Height	660 mm
Depth	750 mm
Width	840 mm
Weight	85 kg

Drawer (optional)	
Height	145 mm
Depth	405 mm
Width	480 mm

Table	
Width	510 mm
Depth	353 mm

Environmental conditions

Temperature	+10°C to +35°C (50-95°F)
Relative humidity	0 - 85 % (non-condensing, in operation)
Atmospheric pressure	660 - 1060 mbar (500 - 800 mmHg), corresponding to altitudes up to about 3000 meters above sea level
Storage temperature	-10°C to +60°C (14-140°F)

Electrical requirements

The unit is designed to be powered from the mains power supply. A back-up battery function is provided.

Power supply	220 - 240 VAC (±10%), 50/60 Hz or 100 - 120 VAC (±10%), 50/60 Hz
Maximum power consumption	220 - 240 V: 2 A (ADU + AM with CRT display) 10 A (above + auxiliary outlet) 100 - 120 V: 4 A (ADU + AM with CRT display) 12 A (above + auxiliary outlet)
Grounding	Hospital grade
Safety class	IEC Class I, type B
Protection against ingress of water	Class IPX1
Back-up battery capacity	With fully charged batteries: More than 20 min. (typically 30 min.) of use of the ADU.
Battery charging time	4 hours

Electrical connections

Auxiliary outlets	1 mains power outlet on the rear side for an Anesthesia Monitor. Optional: 3 outlets
Fuses	4 x T4A in 220-240 V units 4 x T5A in 100-120 V units
Voltage	220 - 240 VAC, 50/60 Hz 100 - 120 VAC, 50/60 Hz
Nominal output currents	220 - 240 V units, 2 A socket 100 - 120 V units, 3 A socket Max. total 8 A
Data connector	9-pin female D-connector for serial I/O and analogue input

Display

Display type	Active matrix color LCD
Size	10.4" diagonal
Display resolution	VGA resolution, 640X480
Controls	14 membrane switches and ComWheel
Indicators	Red and yellow LCDs

Trends

Trend resolution	
Resolutions for continuous data:	
up to 20 min.	10 sec.
up to 2 hours	1 min.
up to 4 hours	2 min.
up to 12 hours	6 min.
up to 24 hours	12 min.

Continuous trend information together with time discrete events are stored for the latest 24 hours with one-minute resolution for all ADU parameters.

Alarms

The following alarms are user adjustable:

High pressure alarm, Ppeak High (in AUTO mode)	8 - 80 cmH_2O, always > Ppeak Low + 2 cmH_2O (factory default 30 cmH_2O)
High pressure alarm, Ppeak High (in MAN mode)	6 - 80 cmH_2O (factory default 40 cmH_2O)
Low pressure alarm, Ppeak Low (in AUTO mode)	6 - 78 cmH_2O or PEEP + 4 to Ppeak High - 2 NOTE: Can not be set higher than Ppeak High

The following pressure alarms are non-adjustable:

Negative pressure alarm	Alarm if the airway pressure stays below a (sub-atmospheric) limit continuing for a certain time.
Sustained pressure alarm, PEEP High	Alarm if the airway pressure exceed a limit continuing for longer than 15 seconds.

Gas Delivery

Gas supply

Wall supply	
Gas connectors	O_2 - AIR - N_2O - VAC (optional) - EVAC
Inlet pressure	270 - 800 kPa (2.7 - 8 bar)
Gauges	O_2, Air, N_2O: 0 - 1000 kPa (0 - 10 bar)
Accuracy of gauges	± 4 % of full scale
O_2, Air, N_2O safety valves opening pressure	900 kPa (9 bar)

Reserve gas cylinders	
Reserve gas yokes	Pin/DIN index for O_2, N_2O
Gauges	O2: 0 - 31.5 MPa (0 - 315 bar; 0-4569 PSI) N2O: 0 - 10 MPa (0 - 100 bar; 0-1450 PSI) Air: 0 - 31.5 MPa (0 - 315 bar; 0-4569 PSI)
Accuracy of gauges	± 4 % of full scale
Safety valves opening pressure	700 kPa (7 bar)

Fresh Gas Control Unit

Fresh gas outlet	The ADU has a coaxial 22 mm / 15 mm conical fresh gas outlet in compliance with EN 1281-1.
Overpressure valve in fresh gas outlet	80 cmH_2O
Extra outlets	Optional outlets for vacuum (max. 1 pcs), O2 (max. 2 pcs) and Air (max. 2 pcs). Max. total number of outlets is: three on the left and one on the right side. Flow from and pressure at the outlets are dependent on the hospital wall pressure.
O_2 flush	27 l/min. for units with A-WGU-00. 35 – 50 l/min. for units with A-WGU-01to -03

Flow controladjustments	Flow delivery ranges
O_2	0 - 10 l/min. as single gas 0 - 8.5 l/min. together with max. 4 l/min. Air or N_2O flow.
AIR	0 - 10 l/min. as single gas. 0 - 8.5 l/min. together with max. 4 l/min. O_2 flow
N_2O	0 - 8.5 l/min. together with max. 4 l/min. O_2 flow.

Accuracy specifications applied to above mentioned nominal adjustment ranges. Available maximum flows may exceed the above mentioned values.

Electronic flow measurement	**Accuracy ***
O_2	± 10 % or ±20 ml/min, whichever greatest
AIR	± 10 % or ±20 ml/min, whichever greatest
N_2O	± 10 % or ±20 ml/min, whichever greatest

*) Note! All accuracy specifications refer to the 0.1 - 10 l/min. flow range.

O_2, Air, N_2O:	**Resolution**
0 – 1.0 l/min.	0.05 l/min.
1.0 - 10 l/min.	0.1 l/min.
Hypoxic Control	Electronic O_2% control is calibrated to guarantee 25 ± 4 vol. % O_2 concentration.

Electronically Controlled Vaporizer and Aladin Cassette

Electronically controlled vaporizer for delivery of five agents: Halothane, Isoflurane, Enflurane, Sevoflurane and Desflurane.

The Aladin Cassettes can be handled safely without excessive leakage of anesthetic agent to the environment.

NOTE: The ADU vaporizer performs as an ordinary concentration calibrated vaporizer regarding the effects of varying ambient pressure. The nominal agent volume % setting is graduated at sea level ambient pressure (760 mmHg). If the vaporizer is used at higher altitudes (decreased ambient pressure), the delivered agent volume % will be higher than the set agent volume % in relation to the decrease of the ambient pressure. This is due to the agent partial pressure being independent of the ambient pressure.

Filling	
Filling system	Adapter filling: Rectangular key adapter filling system for Halothane, Isoflurane, Enflurane and Sevoflurane. Quik Fil™ system according to Abbot's for Sevoflurane. Cylindrical key adapter filling system compatible to the Ohmeda Saf-T-Fil™ bottle for Desflurane.
Filling speed	> 2 ml/s
Overfilling protection	Overfilling prevention systems built into the cassettes.

Liquid capacity	
Maximum	250 ml
Normally possible to fill up when cassette indicator shows empty	150 ml (residual volume 100 ml)
Cassette	
Empty weight	Enflurane, Isoflurane , Sevoflurane with key filler: 2.0 kg Halothane with keyed filler, Sevoflurane Quik Fil: 2.5 kg Desflurane: 3 kg
Height	7 cm
Depth	23 cm
Width	14 cm

Anesthetic agent delivery	
Minimum fresh gas flow for agent delivery	0.2 l/min
Agent setting ranges	
Halothane, Enflurane, Isoflurane	OFF , 0.1 - 5 % in fresh gas flow, resolution 0,1 %
Sevoflurane	OFF , 0.1 - 8 % in fresh gas flow, resolution 0.1 %
Desflurane	OFF , 0.5 -18 % in fresh gas flow, resolution 0.5 %
Accuracy	
All agents in typical operating conditions. Fresh gas flow range 0.2 - 8 l/min. Ambient temperature 18 -25° C. Sea level ambient pressure.	± 10 % of setting or ±3 % of full scale
In other operating conditions **	± 20 % of setting or ±5 % of full scale
Response Time	
To 90 % of step; measured at fresh gas outlet	< 20 s at a fresh gas flow of 3 l/min

**) The anesthetic agent accuracy specification is valid at typical operating conditions: fresh gas flow range 0.2 l/min - 8 l/min, ambient temperature 18°C - 25°C, sea level ambient pressure. In other operating conditions: ±20% of setting or ±5% of full scale whichever is the greatest.

**) Sevoflurane concentrations above 5% may not be reached if the ambient temperature is below 18°C and the fresh gas flow above 5 l/min.

**) The effect of the fresh gas composition, back pressure and temperature variations on the agent concentration are included in the accuracy specification.

Ventilation

Electronic Ventilator including Bellows Block

Description

The ventilator is an electronically controlled, time cycled flow generator delivering tidal volumes compensated for the actual inspiratory fresh gas flow and measured breathing circuit compliance.

The ventilator includes a maintenance free internally integrated PEEP proportional valve.

The ventilator incorporates a switch operation from manual or spontaneous ventilation (Man/Spont) to controlled mechanical ventilation (AUTO). Manual ventilation is direct, i.e. the rebreathing bag is directly connected to the patient breathing circuit.

General	
Driving gas	Compressed air or oxygen. If the supply of primary gas is lost the secondary gas is automatically switched in. Switch activating pressure: 250 kPa (2.5 bar; 36.3 PSI)
Driving gas pressure	270 - 800 kPa (2.7 - 8 bar; 39.2-116 PSI)
Driving gas consumption	Approx. same as minute volume in volume controlled mode. In PCV the consumption is dependent on the Pressure Limit.
Gas supply, O_2 alarm	Alarm activating pressure: 250 kPA (2.5 bar; 36.3 PSI)
Max. inspiratory flow	80 l/min.
Minute volume (max.)	30 l/min.
Inspiratory flow pattern	Constant flow in volume controlled mode Decreasing flow in pressure controlled mode

Controls	
Ventilation control	Auto/Man. selector (mechanical)
Tidal volume Option: alternative minute volume setting	20 - 1400 ml, (factory default 500 ml)
Tidal volume resolution:	
20-50 ml	2 ml
50-100 ml	5 ml
100-300 ml	10 ml
300-1000 ml	25 ml
above 1000 ml	50 ml
Minute volume Option: alternative tidal volume setting	0.1 - 30 l/min. (factory default 5.0 l/min.)
Resolution	0.1 l/min.
Pressure limit	5 – 40 cmH_2O above measured PEEP
Resolution	1 cmH_2O

Controls	
Respiration rate Resolution	2 – 60 breaths/minute (factory default, 10) 1 breath/minute
Patient weight (kilos) Resolution	3 - 100 kg 0.5 kg within 3-10 kg range 1 kg within 10-30 kg range 5 kg within 30-100 kg range
Inspiration/expiration ratios	1:4.5, 1:3, 1:2.5, 1:2, 1:1.5, 1:1, 2:1, (factory default, 1:2), not available in SIMV. Optional: alternative inspiratory time in seconds or %. Minimum expiratory time: 0.5 sec
Inspiratory time	0.35 - 20 sec Optional: alternative I:E ratio or Inspiratory time percentage
Inspiratory time percentage	18 - 67 % of whole cycle (1:4.5 -> 18 % and 2:1 -> 67 %), not available in SIMV Optional: alternative I:E ratio or inspiratory time in seconds
Inspiratory pause	0 – 60 % of inspiratory time with 5 % increments, (factory default 25%), available in Volume Controlled Ventilation and SIMV
PEEP	OFF: 2 - 4 cmH_2O due to the weight of a standing bellows system. 5 - 20 cmH_2O: Resolution 1 cmH_2O, factory default OFF. PEEP is limited to 10 cmH_2O if Tidal Volume is less than 100 ml.
Sigh	OFF/ON, 1.5 x TV every 100th breath. Not available in SIMV or Pressure Control
Trigger level for SIMV from baseline Resolution	-0.5 to - 5 cmH_2O (default -1.0) 0.1 cmH_2O
Trigger window for SIMV Resolution	5 – 95 % from expiratory time Minimum expiratory time: 0.5 sec 1 %
Inspiratory Rise Time	Pressure rise in PVC mode as % of inspiration time: Slow (90%), medium (50%) (default), fast (10%). Shortest time is 300 ms.

Accuracy	
Tidal volume accuracy	20 - 50 ml: ±20 % of set value or 5 ml, whichever is the greater. ≥50 ml: typically ±5 % of set value or 10 ml, whichever is the greater. In extreme cases not more than ±10 %. Compensated for fresh gas flow up to 50 % of actual minute volume. Compensated for machine compliance. Independent of gas composition. Accuracy valid for airway pressure ≤ 30 cmH_2O. Delivered volume will decrease at high pressure; -20% at 100 cmH_2O.
Tidal volume repeatability	Variation < 10% in the range 20 - 100 ml
Minute volume accuracy	See tidal volume
Pressure control accuracy	± 2 cmH_2O
Resp. Rate, I:E, Pause, Insp. time accuracy	± 60 ms
PEEP accuracy	± 2 cmH_2O
Sigh accuracy	± 10 % of volume ± 60 ms timing

Circuit pressure monitoring	
Measuring range	- 40 to 100 cmH_2O
Measuring accuracy	± 4 % of value or ± 2 cmH_2O
Display resolution	1 cmH_2O
Displayed values	**Parameters**
Volume mode SIMV mode PCV mode Man mode	Ppeak, Pplat, PEEP Ppeak, Pplat, Pmin Ppeak, PEEP Ppeak, Pmin

Circuit pressure regulation Automatic ventilation mode (AUTO mode)	
Adjustable maximum pressure release , Pmax Release (Software controlled pressure limiting)	(Ppeak Low + 2). 80 cmH_2O (Default 40 cmH_2O)
Circuit pressure regulation Manual/ Spontaneous ventilation mode (MANUAL mode)	
APL valve adjustment range	1.5 - 80 cmH_2O
APL accuracy setting	
1.5 cmH_2O	0.5 - 5 cmH_2O, Fresh gas flow 3 to 10 l/min.
20 cmH_2O	15 - 30 cmH_2O, Fresh gas flow 3 to 10 l/min.
80 cmH_2O	over 75 cmH_2O, Fresh gas flow 3 to 10 l/min.

Patient Breathing Systems

Refer to the technical information tables for the Compact Block patient circuit and the standard patient circuit with absorber.

Any breathing circuit compatible with a 22/15 mm coaxial fresh gas outlet may be used. A patient circuit used together with tubing and Bellow block must comply with the prEN740 accepted resistance stipulation. The compliance for the entire breathing circuit must not exceed 7 ml/ cmH_2O.

The employed patient circuit must have unidirectional valves for the inspiratory and expiratory lines as well as a connection for fresh gas when required (Bain type circuits excluded).

Patient circuits with APL valve must not be used for the ADU to avoid the risk for confusion due to multiple pressure limiting devices.

NOTE: It has been found that carbon monoxide (CO) tends to build up in unused anesthesia units.

Exchange absorbent in a unit that has been idle for more than 48 hours. Also flush the system with O_2 before use.

Scavenging

Maximum extracted flow	50 l/min or 40 l/min if silencer (8502504) installed
Normal minimum extracted flow	25 l/min (independent of fresh gas flow)
Passive scavenging	Rear panel scavenging connector. Differential pressure 29 cmH_2O at 25 l/min
Extracted flow with A-SEJ2 ejector (Active scavenging with optional scavenging ejector)	Minimum 25 l/min at a driving pressure of 250 - 800 kPa (2.5 - 8 bar; 36.3-116 PSI) Driving gas: Air

7 FORMS AND CHARTS

The following documents may come in very handy to keep a check on what to do and what has been done during long and complicated checking and maintenance procedures. Also included are a number of useful diagrams and tables.

- Installation checklist
- Functional check procedure
- One year maintenance and Three year maintenance
- Pressure conversion table
- Pneumatic symbol chart
- Pneumatic diagram Frame pneumatics A-AUF
- Pneumatic diagram Ventilator A-EV1
- Pneumatic diagram Fresh Gas Control Unit A-FGC1
- Health and safety declaration form

Make copies of the most frequently used forms and keep a stock available.

Installation check list, ADU ID: 40 000 000 and greater

Serial number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:

Setting up the anesthesia delivery unit

- ☐ Unpack the unit according to the *"Open Me First"* instructions
- ☐ Add pipeline inlet connectors to gas hoses
- ☐ The temperature of the unit has stabilized to room temperature
- ☐ Power cord
- ☐ Batteries
- ☐ Pipeline supply gas hoses
- ☐ Scavenging
- ☐ Vacuum (optional)
- ☐ Reserve gas cylinders (optional)
- ☐ Fresh gas outlet
- ☐ Aux. quick gas connectors (optional)
- ☐ Aux. mains outlets (optional)

Connecting the monitors

- ☐ AS/3 or S/5 Anaesthesia Monitor central unit
  - ☐ AM video display 14" or 15" (optional)
  - ☐ AM LCD display (optional)
  - ☐ Transfer of parameters

- ☐ Capnomac Ultima
  - ☐ Transfer of parameters

Configuring software

- ☐ Check ambient pressure
- ☐ Check driving gas
  - ☐ Air
  - ☐ O_2
- ☐ Configure user defaults
- ☐ Save user defaults configuration

Functional check

- ☐ Functional check performed

Functional check procedure, ADU ID: 40 000 000 and greater

A-AUF ID:	Date: (YY/MM/DD) / /
Hospital	Performed by:

OK Failed

Leak tests ☐ ☐

AUTO mode	= ml/min
MAN mode	= ml/min
Compliance	=

Frame

1. External check ☐ ☐

Wall gas unit

2. Central inlets ☐ ☐

O_2	2.7-8 *100 kPa	= *100 kPa
AIR	2.7-8 *100 kPa	= *100 kPa
N_2O	2.7-8 *100 kPa	= *100 kPa

3. High pressure & non-return valves ☐ ☐

Pressure gauges and Pressure Sensors

	Test Device	Pressure gauges	Pressure sensor
O_2	=	= *100 kPa	= *100 kPa
AIR	=	= *100 kPa	= *100 kPa
N_2O	=	= *100 kPa	= *100 kPa

Tolerance to Test Device +/- 0.4 bar (40 kPa)

High pressure leakage ☐ ☐

< 7kPa during 2 minutes (3 gases at same time)

Non-return valves ☐ ☐

< 20 kPa during 2 minutes for each valve tested.

4. Gas cylinder and yokes ☐ ☐

Yoke Regulated Pressure

O_2/Air	2.7-5.5*100 kPa	= *100 kPa
O_2/Air	2.7-5.5*100 kPa	= *100 kPa
N_2O	2.7-5.5*100 kPa	= *100 kPa

OK Failed

5. Cross-connections ☐ ☐

AIR	21± 3% O_2	= % O_2
O_2	100 ± 3% O_2	= % O_2
N_2O	N_2O: 50 ± 3% O_2	= % O_2

6. O_2flush ☐ ☐

A-WGU-00	25-35 l/min	= l/min
A-WGU-01	35-50 l/min	= l/min

7. Evac outlet ☐ ☐

Check that the patient circuit pressure does not drop below 0 cmH$_2$O .

Central electronics

8. Auxiliary mains socket outlets ☐ ☐

9. Batteries ☐ ☐

Check that the ADU has worked on battery power for 15 minutes.

10. Display ☐ ☐

11. Keyboard

12. Hardware watchdog ☐ ☐

13. GSP watchdog ☐ ☐

Fresh gas control unit

14. Fresh gas leakage (no cassette) ☐ ☐

Air	< 10 cmH$_2$O in 30 s	= cmH$_2$O
N_2O	< 10 cmH$_2$O in 30 s	= cmH$_2$O

15. Flow controls ☐ ☐

ADU l/min	Tolerance l/min	Measured O_2 l/min	Measured AIR l/min
0.6	0.54 - 0.66		
2.0	1.8 - 2.2		
7.0	6.3 - 7.7		
10.0	9.0 - 11.0		
NOTE: Ambient pressure affects tolerances.			

OK Failed

16. Fan cassette housing ☐ ☐

17. Fresh gas outlet safety valve ☐ ☐

Total Flow	**Limit**	**Measured**
10l/min	80-100 cmH$_2$O	cmH$_2$O

18. N$_2$O / O$_2$ ratio control ☐ ☐

O$_2$	**O$_2$%**	**Measured**
3.0 l/min	22-28	O$_2$%
2.0 l/min	22-28	O$_2$%
1.0 l/min	22-28	O$_2$%
0,5 l/min	22-28	O$_2$%

N$_2$O flow falls to zero when O$_2$ flow goes below 0.10 l/min

N$_2$O supply pressure alarm initiated

19. Agent control ☐ ☐

Agent	**flow 1 l/min**	**flow 8 l/min**	**Tolerance**
0.5	%	%	(0.35-0,65 agent %)
3.0	%	%	(2.7-3.3 agent %)
5.0	%	%	(4.5-5.5 agent %)
NOTE: Ambient pressure affects tolerances.			

20. Aladin Cassette

Checked Cassette

☐ Halothane ☐ ☐

☐ Enflurane ☐ ☐

☐ Isoflurane ☐ ☐

☐ Sevoflurane ☐ ☐

☐ Desflurane ☐ ☐

Ventilator

21. O$_2$ and Air alarm ☐ ☐

22. Circuit pressure ☐ ☐

Measurement (Pcirc)

Tolerance 28-32 cm when test device shows 30 cm H$_2$O

Display value	cmH$_2$O

23. Pilot pressure ☐ ☐

OK Failed

24. Delivered tidal volume ☐ ☐

Set Tidal Volume	**Rate**	**Tolerance ml / min**	**Tidal volume ml / min**
1000	6	900-1100	
200	20	180-220	

(Tolerance including test device error range)

25. Driving gas selection unit

Check that:

The delivery unit uses primary gas. ☐ ☐

The delivery unit uses secondary gas when primary gas inlet is disconnected. ☐ ☐

The ventilation stops when both primary and secondary gas inlets are disconnected. ☐ ☐

The ventilation starts after connecting the secondary gas. ☐ ☐

The delivery unit changes to primary gas after connecting the primary gas. ☐ ☐

26. PEEP function ☐ ☐

Settings	**Tolerances**	**Measured**
0	0-4 cmH$_2$O	cmH$_2$O
5	3-7 cmH$_2$O	cmH$_2$O
15	13-17 cmH$_2$O	cmH$_2$O

27. PCV check ☐ ☐

Pre-set pressure plus PEEP reached

28. Electrical safety check ☐ ☐

29. System check

FULL Check ☐ ☐

Check Log: ☐ ☐

Comments:

Maintenance schedule, ADU ID: 40 000 000 and greater

Serial number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:
☐ One year ☐ Three year ☐ Other	

One year maintenance ADU (Order No. 893641)

1. ☐ Replace gas inlet connector O-rings (3) in A-WGU (3 pcs)
2. ☐ Replace gas inlet filters and gaskets (3) in A-WGU (3 pcs)
3. ☐ Replace dust filter in A-ELEC
4. ☐ Replace gasket in A-BB
5. ☐ Replace O-rings on APL valve (3)
6. ☐ Replace O-rings on connectors in A-BB (2)
7. ☐ Replace overflow valve membrane and O-ring for cap in A-BB
8. ☐ Replace fresh gas outlet connector O-ring
9. ☐ Replace O-rings in cassette housing (2)
10. ☐ Replace reservoir tube in A-AUF

Three year maintenance ADU (Order No. 893642)

11. ☐ Replace membranes (2) and O-rings (4), in expiration valve unit of A-EV1
12. ☐ Replace batteries in A-ELEC (4)
13. ☐ Check Vaporizer heating resistor in A-FGC1
14. ☐ Replace chamber seal and O-rings in A-BB (6)

Other maintenance

Compact Circuit maintenance, A-CC1 (One Year kit p/n 42-70015-00) (8770699)

15. ☐ Replace the parts included in kit

Compact Circuit maintenance, A-CC2 (One Year kit p/n 8570071) (8770699)

16. ☐ Replace the parts included in kit

Oxygen Flush maintenance (6 Year p/n 90700 A-WGU-00)

17. ☐ Replace O2 Flush.

O_2 flush kit (6 Year p/n 850093 A-WGU-01-02-03) and Table mouted oxygen flush

18. ☐ Replace the parts included in kit.

Static RAM (8 Year p/n 197230)

19. ☐ Replace static RAM on B-CPU2-01

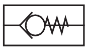
WARNING **Carry out the Functional check after performed maintenance**

Pressure conversion table

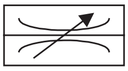
	atm	**cm H_2O**	**kPa**	**mm Hg**	**bar**	**psi**
1 atm		1033	101	760	1.01	14.7
1 cm H_2O	9.7×10^{-4}		0.098	0.74	9.8×10^{-4}	0.014
1 kPa	9.9×10^{-3}	10.2		7.5	0.01	0.145
1 mm Hg	1.3×10^{-3}	1.36	0.13		1.33×10^{-3}	0.019
1 bar	0.99	1019.7	100	750		14.5
1 psi	0.068	70.3	6.89	51.7	0.068	

Pneumatic symbol chart

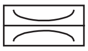
Guide to the symbols used in the pneumatic diagrams of this manual



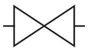
Non-return valve
spring loaded



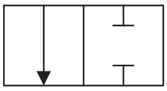
Throttle valve



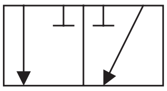
Restrictor



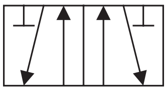
Shut-off valve



Valve 2/2

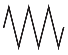


Valve 3/2

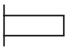


Valve 5/2

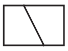
Mechanical control



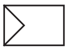
by spring



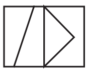
by push button



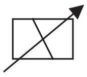
Electronic control
by solenoid



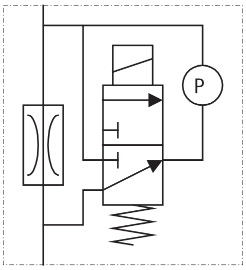
Control with pressure



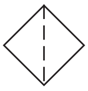
Control by solenoid
and pilot directional valve



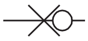
Electronic proportional
control by solenoid



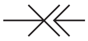
Flow measurement unit



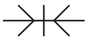
Filter



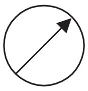
Quick acting coupling,
with non-return valve



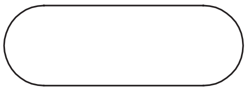
Power take off
with take-off line



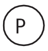
Quick acting coupling



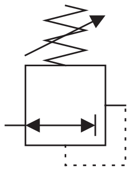
Pressure cauge



Reservoir



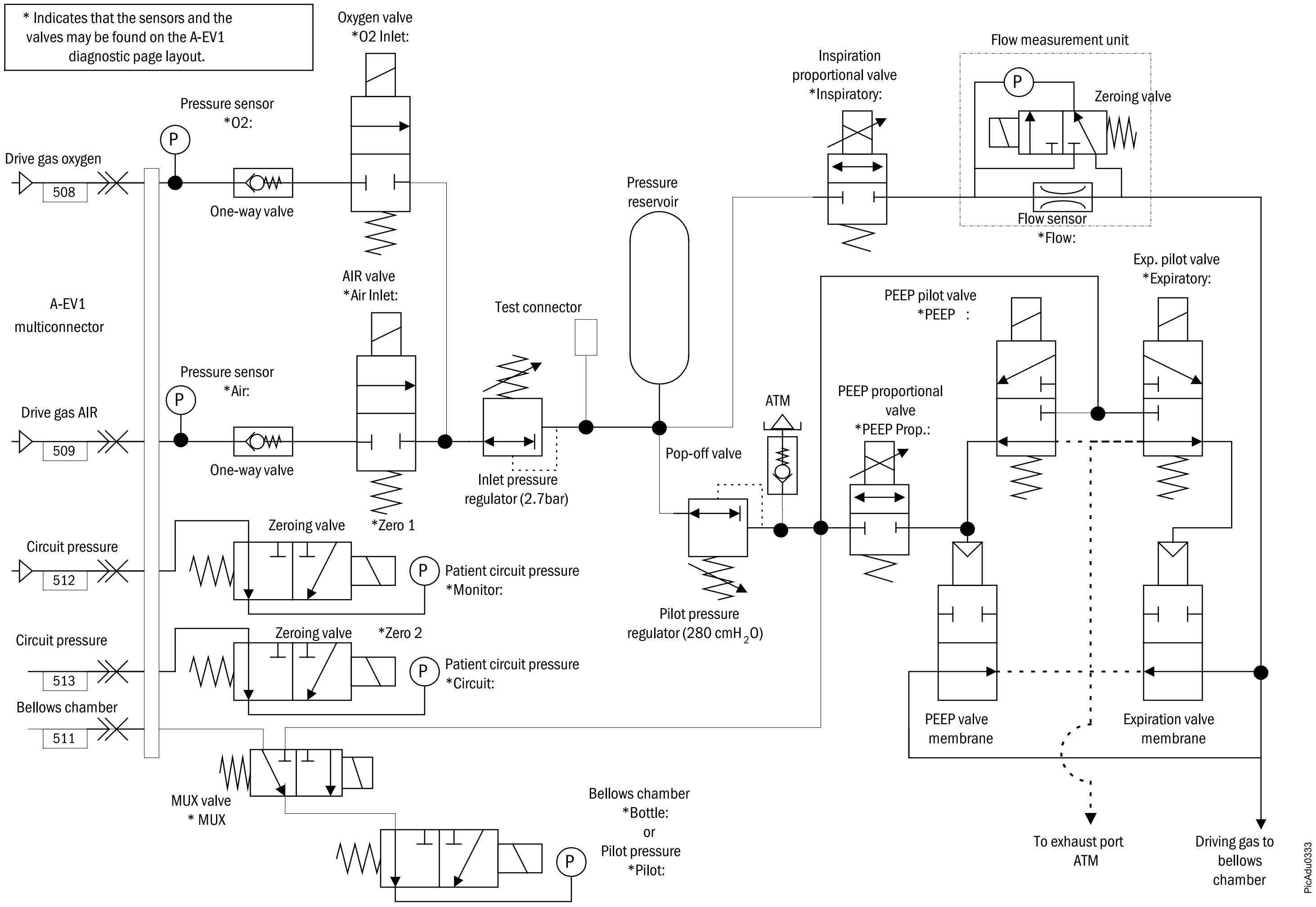
Pressure measuring
instrument



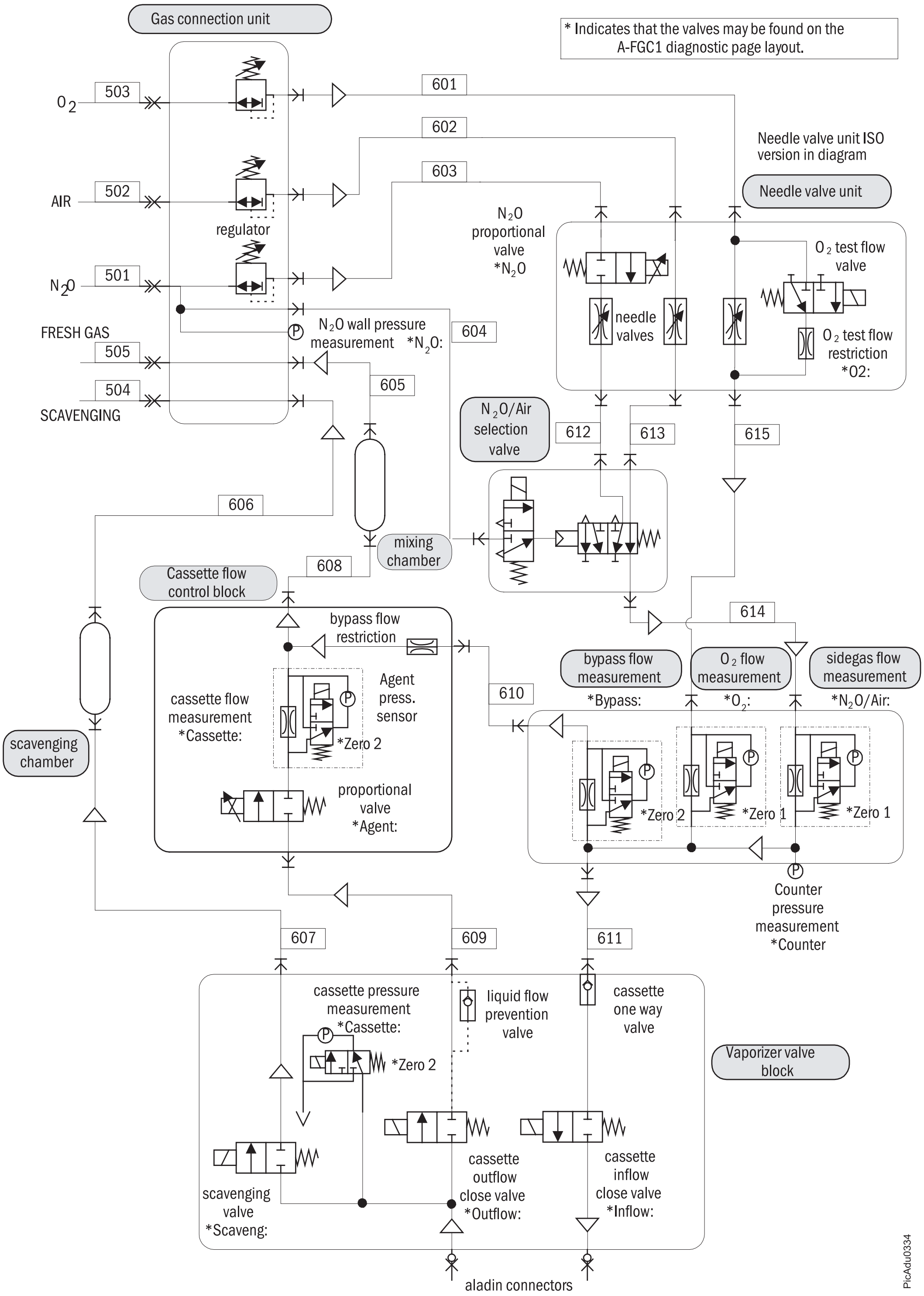
Regulator

PicAdu0330

Pneumatic chart of the Electronic Ventilator A-EV1


* Indicates that the sensors and the valves may be found on the A-EV1 diagnostic page layout.
Oxygen valve
*O2 Inlet:
Pressure sensor
*O2:
P
Drive gas oxygen
508
One-way valve
Inspiration proportional valve
*Inspiratory:
Flow measurement unit
P
Zeroing valve
Flow sensor
*Flow:
Pressure reservoir
AIR valve
*Air Inlet:
A-EV1
multiconnector
Test connector
Exp. pilot valve
*Expiratory:
PEEP pilot valve
*PEEP :
Pressure sensor
*Air:
P
Drive gas AIR
509
One-way valve
ATM
PEEP proportional valve
*PEEP Prop.:
Pop-off valve
Inlet pressure regulator (2.7bar)
Zeroing valve
*Zero 1
Circuit pressure
512
P
Patient circuit pressure
*Monitor:
Pilot pressure regulator (280 cmH$_2$O)
Circuit pressure
Zeroing valve
*Zero 2
513
P
Patient circuit pressure
*Circuit:
Bellows chamber
511
PEEP valve membrane
Expiration valve membrane
MUX valve
* MUX
Bellows chamber
*Bottle:
or
Pilot pressure
*Pilot:
P
To exhaust port ATM
Driving gas to bellows chamber
PicAdu0333

Pneumatic chart of the Fresh Gas Control Unit A-FGC1



* Indicates that the valves may be found on the A-FGC1 diagnostic page layout.

Gas connection unit
O_2
503
AIR
502
N_2O
501
FRESH GAS
505
504
SCAVENGING
regulator
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
N_2O wall pressure measurement *N_2O:
N_2O proportional valve *N_2O
Needle valve unit ISO version in diagram
Needle valve unit
needle valves
O_2 test flow valve
O_2 test flow restriction *O2:
N_2O/Air selection valve
mixing chamber
Cassette flow control block
bypass flow restriction
Agent press. sensor
cassette flow measurement *Cassette:
*Zero 2
proportional valve *Agent:
scavenging chamber
bypass flow measurement *Bypass:
O_2 flow measurement *O_2:
sidegas flow measurement *N_2O/Air:
*Zero 2
*Zero 1
*Zero 1
Counter pressure measurement *Counter
cassette pressure measurement *Cassette:
*Zero 2
liquid flow prevention valve
cassette one way valve
Vaporizer valve block
scavenging valve *Scaveng:
cassette outflow close valve *Outflow:
cassette inflow close valve *Inflow:
aladin connectors
PicAdu0334

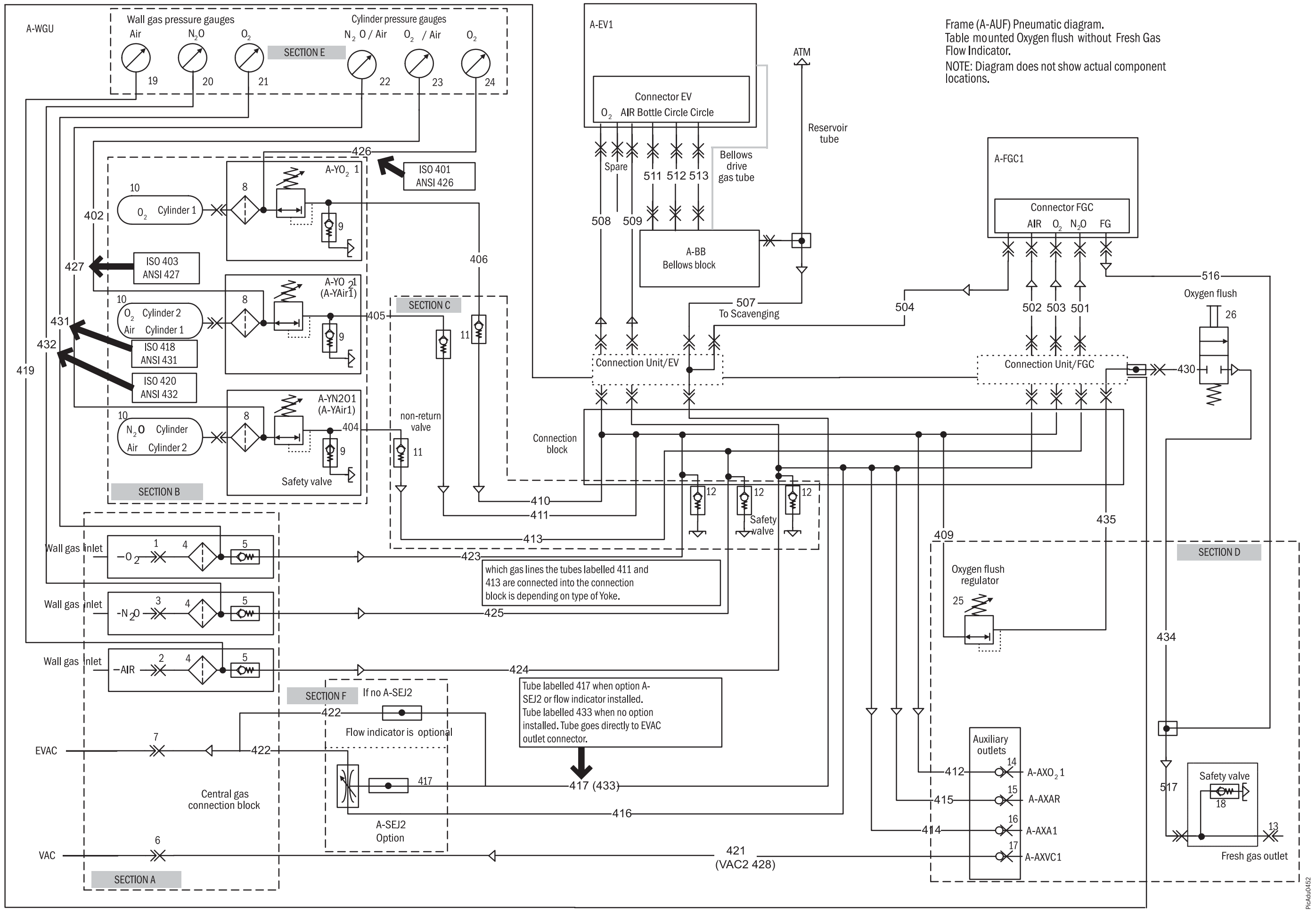
Health and safety declaration form

1. Please note that equipment returned for service, will not be accepted until this form is properly completed.
2. Failure to complete the form or to comply with health and safety cleaning procedures, may endanger Datex-Ohmeda service personnel and may lead to delay in servicing the equipment.

Equipment type/Product No:
Serial No:
I hereby confirm that the above equipment has been properly cleaned and decontaminated. I also agree to give Datex-Ohmeda the sole control of the instrument / system. Cleaning certified: (signature)
Name: (Block letters)
Position in institution or company:
Date (YY/MM/DD) / /

State if the equipment has been in contact with any toxic or hazardous substances that require the service personnel to wear: ☐ Gloves ☐ Inhalation filter ☐ Protective clothing ☐ Other:.. .... None of the above
State phone number where Datex-Ohmeda may obtain more information concerning the instrument / system. Phone No:

Pneumatic chart of Table, frame without A-FGFI



Frame (A-AUF) Pneumatic diagram.
Table mounted Oxygen flush without Fresh Gas Flow Indicator.
NOTE: Diagram does not show actual component locations.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed. Tube labelled 433 when no option installed. Tube goes directly to EVAC outlet connector.

A-WGU
Wall gas pressure gauges
Air
N2O
O2
SECTION E
Cylinder pressure gauges
N2 O / Air
O2 / Air
O2
19
20
21
22
23
24
A-EV1
Connector EV
O2 AIR Bottle Circle Circle
Spare
511 512 513
Bellows drive gas tube
508
509
A-BB
Bellows block
ATM
Reservoir tube
507
To Scavenging
Connection Unit/EV
A-FGC1
Connector FGC
AIR O2 N2O FG
504
502 503 501
516
Oxygen flush
26
Connection Unit/FGC
430
426
ISO 401
ANSI 426
A-YO2 1
10
8
O2 Cylinder 1
9
402
427
ISO 403
ANSI 427
406
A-YO 2
(A-YAir1)
10
O2 Cylinder 2
Air Cylinder 1
405
SECTION C
11
431
432
ISO 418
ANSI 431
ISO 420
ANSI 432
419
A-YN2O1
(A-YAir1)
N2O Cylinder
Air Cylinder 2
404
non-return valve
Safety valve
SECTION B
Connection block
12
12
12
Safety valve
410
411
413
435
409
SECTION D
Wall gas inlet
O2
1
4
5
423
Wall gas inlet
N2O
3
425
Wall gas inlet
AIR
2
424
Oxygen flush regulator
25
434
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
Central gas connection block
417
A-SEJ2
Option
417 (433)
416
VAC
6
421
(VAC2 428)
SECTION A
Auxiliary outlets
412
14
A-AXO2 1
415
15
A-AXAR
414
16
A-AXA1
17
A-AXVC1
517
Safety valve
18
13
Fresh gas outlet
PicAdu0452

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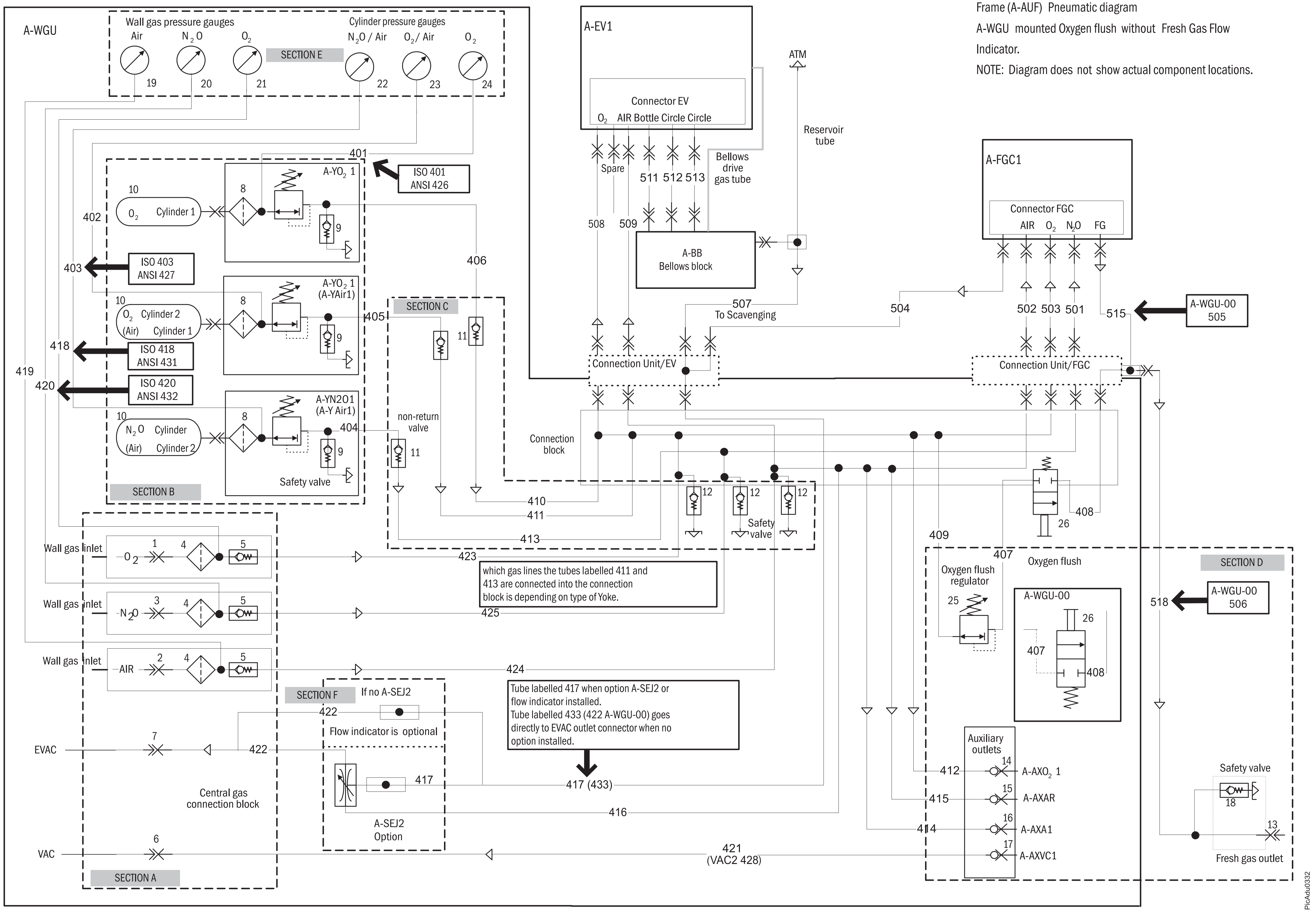
Pneumatic chart of A-WGU, frame without A-FGFI



Frame (A-AUF) Pneumatic diagram

A-WGU mounted Oxygen flush without Fresh Gas Flow Indicator.

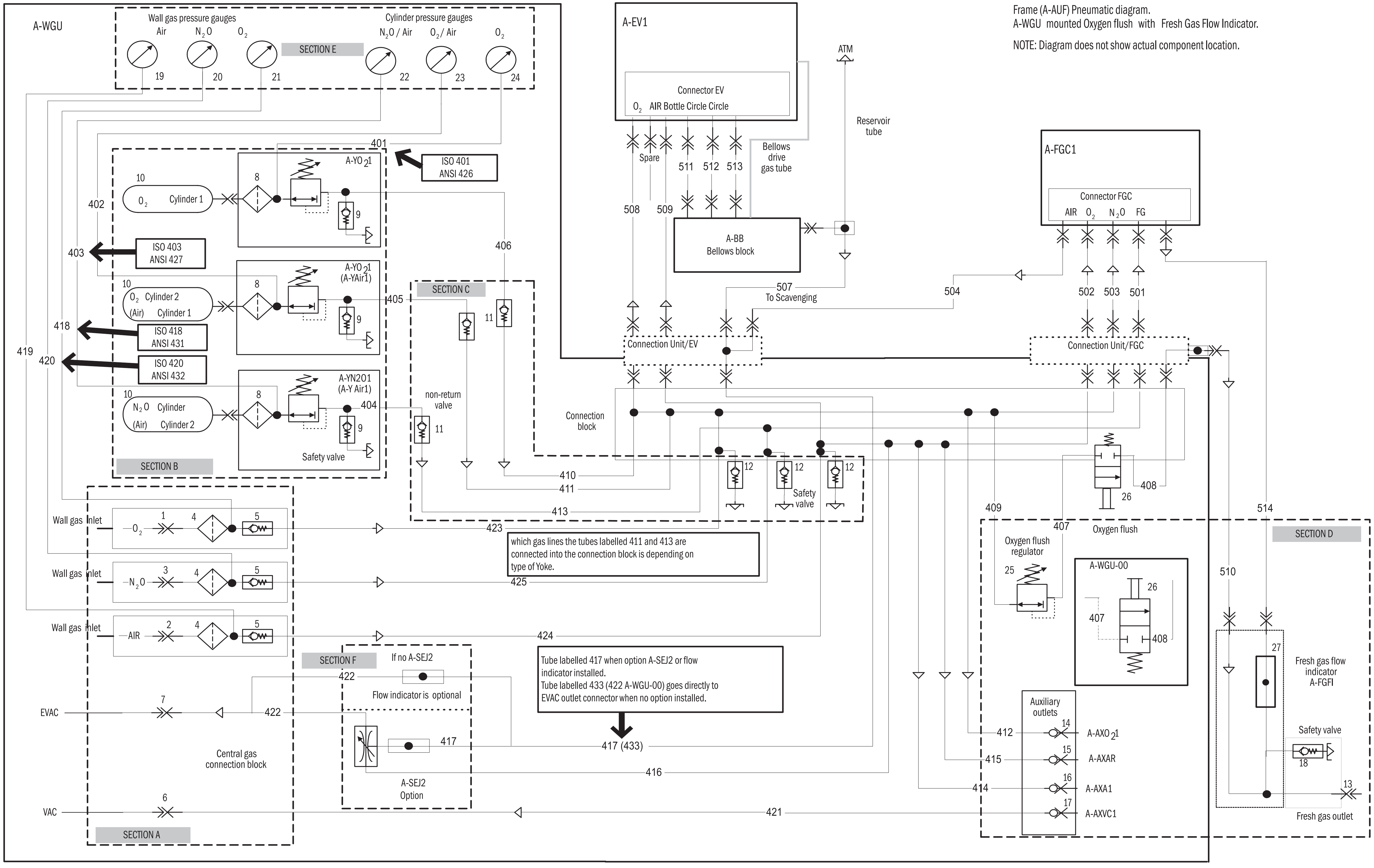
NOTE: Diagram does not show actual component locations.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed.
Tube labelled 433 (422 A-WGU-00) goes directly to EVAC outlet connector when no option installed.

A-WGU
Wall gas pressure gauges
Air
N2O
O2
SECTION E
Cylinder pressure gauges
N2O / Air
O2/ Air
O2
19
20
21
22
23
24
401
ISO 401
ANSI 426
A-YO2 1
10
8
O2 Cylinder 1
9
402
403
ISO 403
ANSI 427
406
A-YO2 1
(A-YAir1)
O2 Cylinder 2
(Air) Cylinder 1
405
SECTION C
11
418
ISO 418
ANSI 431
419
420
ISO 420
ANSI 432
A-YN2O1
(A-Y Air1)
N2O Cylinder
(Air) Cylinder 2
404
Safety valve
non-return valve
SECTION B
Wall gas inlet
O2
1
4
5
423
N2O
3
425
AIR
2
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
417
A-SEJ2 Option
417 (433)
416
Central gas connection block
VAC
6
421
(VAC2 428)
SECTION A
A-EV1
Connector EV
O2 AIR Bottle Circle Circle
Spare
508
509
511 512 513
Bellows drive gas tube
ATM
Reservoir tube
A-BB
Bellows block
507
To Scavenging
Connection Unit/EV
Connection block
410
411
413
12
Safety valve
A-FGC1
Connector FGC
AIR O2 N2O FG
504
502 503 501
515
A-WGU-00
505
Connection Unit/FGC
26
408
409
407
Oxygen flush regulator
Oxygen flush
25
A-WGU-00
26
407
408
SECTION D
518
A-WGU-00
506
Auxiliary outlets
412
14
A-AXO2 1
415
15
A-AXAR
414
16
A-AXA1
17
A-AXVC1
Safety valve
18
13
Fresh gas outlet
PicAdu0332

Pneumatic chart of A-WGU, frame with A-FGFI



Frame (A-AUF) Pneumatic diagram.
A-WGU mounted Oxygen flush with Fresh Gas Flow Indicator.

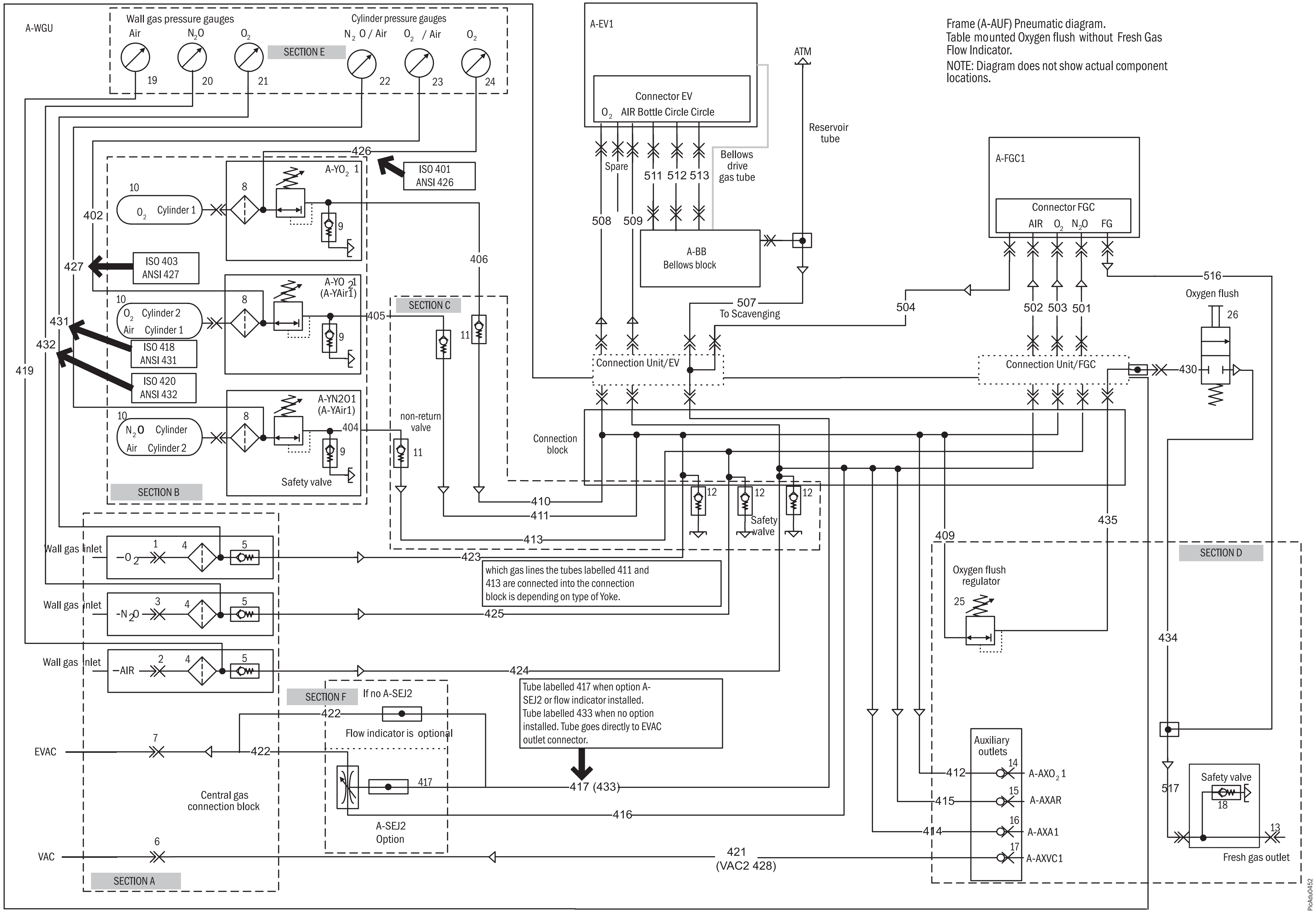
NOTE: Diagram does not show actual component location.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed.
Tube labelled 433 (422 A-WGU-00) goes directly to EVAC outlet connector when no option installed.

A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
Cylinder pressure gauges
N_2O / Air
O_2/ Air
O_2
SECTION E
19
20
21
22
23
24
401
ISO 401
ANSI 426
A-YO21
8
10
O_2 Cylinder 1
9
402
403
ISO 403
ANSI 427
A-YO21
(A-YAir1)
O_2 Cylinder 2
(Air) Cylinder 1
405
406
SECTION C
11
418
ISO 418
ANSI 431
419
420
ISO 420
ANSI 432
A-YN2O1
(A-Y Air1)
N_2O Cylinder
(Air) Cylinder 2
404
Safety valve
non-return valve
SECTION B
410
411
413
Wall gas Inlet
O_2
1
4
5
423
N_2O
3
425
AIR
2
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
Central gas connection block
417
A-SEJ2
Option
417 (433)
416
VAC
6
421
SECTION A
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
Spare
511
512
513
Bellows drive gas tube
ATM
Reservoir tube
508
509
A-BB
Bellows block
507
To Scavenging
Connection Unit/EV
Connection block
12
Safety valve
A-FGC1
Connector FGC
AIR O_2 N_2O FG
504
502
503
501
Connection Unit/FGC
26
408
409
407
514
Oxygen flush
Oxygen flush regulator
25
A-WGU-00
SECTION D
510
27
Fresh gas flow indicator
A-FGFI
Safety valve
18
13
Fresh gas outlet
Auxiliary outlets
412
14
A-AXO21
415
15
A-AXAR
414
16
A-AXA1
17
A-AXVC1
Pc4du0331

Pneumatic chart of Table, frame without A-FGFI



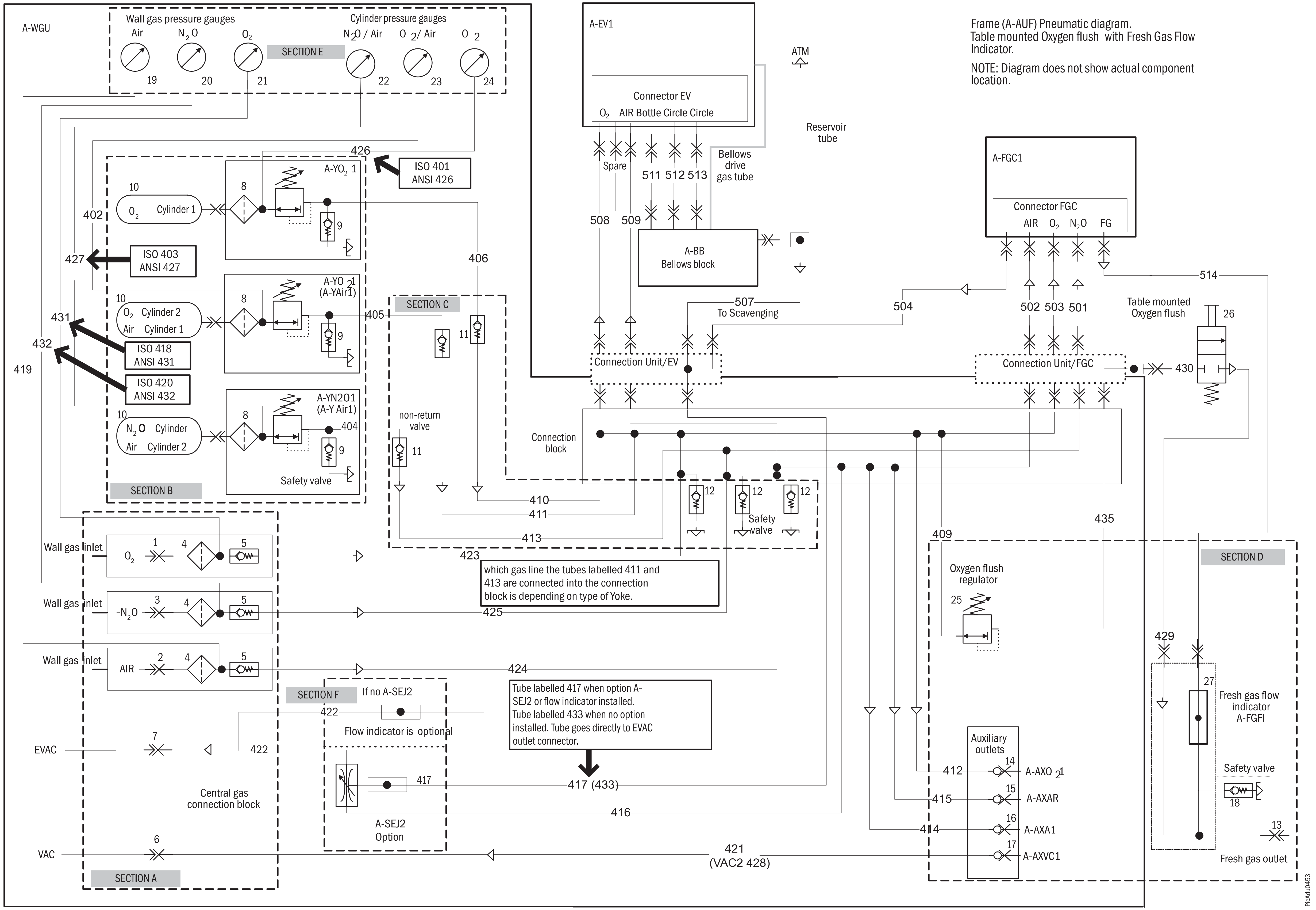
Frame (A-AUF) Pneumatic diagram.
Table mounted Oxygen flush without Fresh Gas Flow Indicator.
NOTE: Diagram does not show actual component locations.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed. Tube labelled 433 when no option installed. Tube goes directly to EVAC outlet connector.

A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
SECTION E
Cylinder pressure gauges
N_2O / Air
O_2 / Air
O_2
19
20
21
22
23
24
426
ISO 401
ANSI 426
A-YO_2 1
10
8
O_2 Cylinder 1
9
402
406
427
ISO 403
ANSI 427
A-YO 2 1
(A-YAir1)
10
8
O_2 Cylinder 2
Air Cylinder 1
405
SECTION C
11
11
431
ISO 418
ANSI 431
432
ISO 420
ANSI 432
419
A-YN2O1
(A-YAir1)
10
8
N_2O Cylinder
Air Cylinder 2
404
9
Safety valve
non-return valve
11
SECTION B
Wall gas inlet
$-O_2$
1
4
5
423
Wall gas inlet
$-N_2O$
3
4
5
425
Wall gas inlet
–AIR
2
4
5
424
EVAC
7
422
SECTION F
If no A-SEJ2
422
Flow indicator is optional
417
A-SEJ2
Option
Central gas connection block
VAC
6
SECTION A
421
(VAC2 428)
417 (433)
416
410
411
413
Connection block
12
12
12
Safety valve
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
Spare
511 512 513
Bellows drive gas tube
508
509
A-BB
Bellows block
ATM
Reservoir tube
507
To Scavenging
Connection Unit/EV
504
A-FGC1
Connector FGC
AIR O_2 N_2O FG
502 503 501
516
Oxygen flush
26
Connection Unit/FGC
430
409
435
SECTION D
Oxygen flush regulator
25
434
Auxiliary outlets
14
412
A-AXO_2 1
15
415
A-AXAR
16
414
A-AXA1
17
A-AXVC1
517
Safety valve
18
13
Fresh gas outlet
PicAdu0452

Pneumatic diagram of table, frame with A-FGFI


A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
SECTION E
Cylinder pressure gauges
N_2O / Air
O_2/ Air
O_2
19
20
21
22
23
24
426
ISO 401
ANSI 426
A-YO₂ 1
10
O_2 Cylinder 1
8
9
402
427
ISO 403
ANSI 427
406
A-YO₂ 1
(A-YAir1)
10
O_2 Cylinder 2
Air Cylinder 1
405
SECTION C
431
432
419
ISO 418
ANSI 431
ISO 420
ANSI 432
11
A-YN2O1
(A-Y Air1)
10
N_2O Cylinder
Air Cylinder 2
404
non-return valve
Safety valve
SECTION B
410
411
413
Wall gas inlet
O_2
1
4
5
423
Wall gas inlet
N_2O
3
425
Wall gas inlet
AIR
2
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
417
Central gas connection block
A-SEJ2
Option
417 (433)
416
VAC
6
421
(VAC2 428)
SECTION A
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
Spare
511 512 513
Bellows drive gas tube
508
509
ATM
Reservoir tube
A-BB
Bellows block
507
To Scavenging
Connection Unit/EV
Connection block
12
Safety valve
A-FGC1
Connector FGC
AIR O_2 N_2O FG
514
504
502 503 501
Table mounted Oxygen flush
26
Connection Unit/FGC
430
409
435
SECTION D
Oxygen flush regulator
25
429
27
Fresh gas flow indicator
A-FGFI
Safety valve
18
13
Fresh gas outlet
Auxiliary outlets
14
412
A-AXO₂1
15
415
A-AXAR
16
414
A-AXA1
17
A-AXVC1
PicAdu0453

Frame (A-AUF) Pneumatic diagram.
Table mounted Oxygen flush with Fresh Gas Flow Indicator.

NOTE: Diagram does not show actual component location.

which gas line the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed.
Tube labelled 433 when no option installed. Tube goes directly to EVAC outlet connector.

8 REVISION HISTORY

This section contains a declaration of the revision status for:

- The complete AS/3 and S/5 Anesthesia Delivery Unit
- The software
- The PC Boards
  NOTE: The reference numbers in the section may not be the same as the spare part order numbers, it is the number stamped on the board. For spare parts numbers please se the specific spare part section s in chapters A-D).

AS/3 and S/5 ADU ID: No. 40 000 000 and greater

NOTE: The changes related to the release of the ADU S/5 was not related technical changes that would affect the safety or performance of the product. The changes was restricted to color, labeling, shape of the touch keys on LCD displays and some minor changes in the ADU main software start-up logo and menu texts (ref. Technical Bulletin AVD STO 00 004).

Frame

ADU	**A-AUF-00**
Date of manufacturing	DEC-1997
Identification Number A-AUF	40 000 000 -
ADU LCD display	D-LCCADU-XX-00. D-LCCADU-XX-01 New color and key pad ref. TB AVD STO 00 004).
Electronic Ventilator	A-EV1-00.
Fresh Gas Control Unit	A-FGC1-00.
Central electronics	A-ELEC-00.
Wall Gas Unit	A-WGU-00. O_2 flush knob mounted in the A-WGU. Maximum O_2 flush flow 25 l/min. No Air yoke option available. A-WGU-01 >40 030 740 O_2 flush valve mounted either in the A-WGU or at the Frame Table Maximum O_2 flush flow maximum 50 l/min A-WGU-02 O_2 flush valve mounted either in the A-WGU or at the Frame Table Maximum O_2 flush flow 50 l/min. White D-O color A-WGU-03 O_2 flush valve mounted at the Frame Table Maximum O_2 flush flow 50 l/min.
AS/3 and S/5 AM Anesthesia Monitor	
LCD display.	D-LCC10W-XX-00. D-LCC 10W-XX-01 New color and key pad ref. TB AVD STO 00 004).

Software

A-EV1 software	**A-FGC1 software**	**Main software**
Initial release Ver. 7.2	Initial release Ver. 7.0	Initial release Ver. 5.1 (S-ADU97)
March 1998. Ver. 7.3 Ref. Technical Bulletin AS/3 ADU 2-98.	March 1998 Ver. 7.1 Ref Technical Bulletin AS/3 ADU 5-98	March 1998 (S-ADU97) Ver. 5.2 Ref Technical Bulletin AS/3 ADU 2-98.
April 1998 (Mandatory upgrade) Ver. 7.4 Ref. Technical Bulletin AS/3 ADU 6-98	September 1998 Ver. 7.2. Ref. Technical Bulletin AS/3 ADU 10-98.	January. 1999 Ver. 5.4 (S-ADU99) (Optional upgrade) New options added in Install/ Units menu: - Portuguese, Danish and US language Patient weight may be set as lbs. Wall pressure may be set in PSI Ref. Technical bulletin AS/3 ADU TB-4-99.
January 1999 (Optional upgrade) Ver. 7.5. Ref. Technical Bulletin AS/3 ADU 2-99.	October 1999 Ver. 7.3. Ref. Technical bulletin AS/3 ADU 10-99.	May 2001 (Optional upgrade) Ver. 6.0 (S-ADU00. Changes related to the release of the S/5 ADU.
Jan 2001 (Optional upgrade but recommended) Ver. 7.6 Ref. Technical Bulletin ADV STO 01 004.	Mars 2000 (Mandatory upgrade) Ver. 7.4. Ref. Technical bulletin ADV ST O 00 001.	May 2001 Ver. 7.0 Launched together with ADU B-CPU4 board. Same functionality as ver. 6.0. Ref. Ref. Technical Bulletin ADV STO 01 00X.
September 2001 Ver. 7.7 Ref. Technical Bulletin ADV STO 01 012.		August 2001 Main software 6.1 for B-CPU2..01 board. Main software 7.1 for B-CPU4..01 board. Ref. Technical Bulletin ADV STO 01 011.

PC Boards

ADU PC-Boards	**Release 1**	**Release 2**	**Release 3**
Mains board.	893052	895052, March 1998 Change: One NTC resistor added to lower start-up current.	895378, April 1998 Change: Design changed. NTC resistor mowed.
Audio amplifier board.	881794		
Battery charger board.	890430	896975, March 1999 Change: Resistor Type R87/R88/R25/R26 Change to OR11.	
B-CPU2.	B-CPU-00-01 (887964)		
ADU B-CPU4.	B-CPU4-00..01, June 2001 Ref. Technical Bulletin ADV STO 01 011		
Digipower board 3.	890483		
Mother board.	889125		
Rectifier board.	892872	892872, Mars 2001 New fuse holder.	
Video controller board.	B-DISP-23-01 (892093)		
A-EV1 CPU board.	889466		
A-EV1 DC/DC board.	881344	896323, Nov. 1998. Change: Eliminated risk for DC/DC converter reset.	
A-EV1 connection board.	889615		

ADU PC-Boards	Release 1	Release 2	Release 3
A-AEV1 Flow sensor board.	884227 Only A-EV1 manufactured before September 1998.		
A-EV1 Flow sensor board including zeroing valve.	8500952		
O_2 and AIR sensor board.	890413	898639, February 2001 (change due to discontinuation of 890413. Ref. Technical bulletin ADV STO 01 003.	
Bottle sensor board.	893301		
Monitor/Circuit sensor board.	890421		
A-FGC1 CPU board.	889396	896513, Jan. 1999. Current limits for the four 12 V outputs is increased.	
A-FGC1 DC/DC board.	881344	896323 , Change: See above	
A-FGC1 connection board.	890185		
Cassette pressure measuring board.	893150	894814, June 1998 Change: New layout, surface mounted.	8501336, March 2000 New type of pressure sensor (Mandatory upgrade).
Sidegas and O_2 measuring board.	893152		
Bypass measuring board.	893151		
Counter pressure measuring board.	893153		

ADU PC-Boards	Release 1	Release 2	Release 3
N_2O pressure sensor board.	890413	898639, February 2001. (change due to discontinuation of 890413. Ref. Technical bulletin ADV STO 01 003.	
Cassette Identification board.	884118	8504118, September 2001 Number on board changed. No functional changes.	
Temperature sensor board.	884320	8503416, April 2001 Number on board changed. No functional changes.	

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9 TECHNICAL BULLETINS

10 GLOSSARY

Abbreviations

For an anesthesiologic vocabulary please see the *“User´s Reference Manual”.*

A

AA	Anesthetic Agent
A-AS1	Aladinslot
A-AUF	Frame Pneumatics
A-AXA1	Extra air outlet
A-AXAR	Extra air outlet
A-AXO21	Extra oxygen outlet
A-BB	Bellows Block
A-CART	ADU Cart
A-CC1	Compact block 1
A-CC2	Compact block 2
ADU	Anesthesia Delivery Unit
A-ELEC	Central Electronics Module
A-EO	Electronic Outlet Box
A-EV1	Electronic Ventilator
A-FGC1	Fresh Gas Control Unit
A-FGFI	Fresh Gas Flow Indicator
A-MFR1	Module Frame Rack
AM	Anesthesia Monitor
ANSI	American National Standards institute
APN	Apnea
APL	Airway Pressure Limiting (valve)
A-SEJ2	Scavenging ejector
ATP	Ambient Temperature and Pressure
ATPD	Ambient Temperature Pressure Dry
AUF	See A-AUF
AUX	Auxiliary
A-VHAL	Aladin cassette Halothane (Key filler)
A-VISO	Aladin cassette Isoflurane (Key filler)
A-VENF	Aladin cassette Enflurane (Key filler)
A-VSEV	Aladin cassette Sevoflurane (Key filler)
A-VSEVQ	Aladin cassette Sevoflurane (Quik Fil)
A-VDES	Aladin cassette Desflurane (Quik Fil)
A-WGU	Wall Gas Unit

B

B-CPU2	CPU board
B-CPU4	CPU board

C

CAL	Calibrate
CO_2	Carbon Dioxide
CE	European Community
CEN	Comité Européen de Normalisation (Standardization)
Compl	Compliance
CmH_2O	Centimeters of water (Unit of pressure)
CMV	Controlled Mechanical Ventilation
CSA	Canadian Standards Association

D

DES	Desflurane
DIN	Deutsche Industrie Norm

DISS	Diameter-Index Safety System
DKD	Deutscher Kalibrierdienst
D-LCCADU	ADU Display
D-LCC10W	Monitor Display (integrated)
D-O	Datex-Ohmeda
D-VHC14	Monitor display 14”
D-VNC15	Monitor display 15”

E

EN	Europäische Norm (Eurpean Standard)
ENF	Enflurane
EMI	Electromagnetic Interference
ET	End tidal (gas concentration)
EU	European Union
EV	See A-EV1
EVAC	Evacuation
Exp.	Expiration

F

FI	Fractional concentration of inspired gas
FGC	See A-FGC1

H

HAL	Halothane
h	Hour(s)
HW	Hardware

I

I:E	Inspiratory:Expiratory time ratio
IEC	International Electrotechnical Commission (Standardization)
Insp.	Inspiration
ISO	International Organisation for Standardization alt. Isoflurane

K

kPa	Kilo Pascal (unit of pressure)

L

l	Liter
LCD	Liquid Crystal Diplay See also D-LCCADU
LED	Light Emitting Diode

M

MAC	Minimum Alveolar Concentration
Man.	Manual
Max.	Maximum
mbar	Millibar (unit of pressure)
ml	Milliliter (1 cc)
Min.	Minute(s) alt. Minimum
mm	Millimeter
mmHg	Millimeters of mercury
MUX	Multiplex Valve
MV	Minute Volume

N

N_2O	Nitrous Oxide
N/A	Not applicable
NIST	National Institute of Standards and Technology
NTC	Negative Temperature Coefficient

O

O_2	Oxygen

P

Pa	Pascal (unit of pressure)

P_{aw}	Airway Pressure
PC	Computer
PCB	Printed Circuit Board
PCMCIA	Software Card
PCV	Pressure Controlled Ventilation
PEEP	Positive End Expiratory Pressure
P/N	Part Number
Pcirc	Circuit Pressure
Pmin	Minimun Pressure
Ppeak	Peak Pressure
Pplat	Plateau Pressure
PS	Patient Spirometry
PSI	Pounds per square inch (unit of pressure)
PTFE	Polytetrafluoroethylene (Teflon)

R

RAM	Random Access Memory
Resp.	Respiration
RR	Respiration Rate

S

s	Seconds
SEV	Sevoflurane
SIMV	Syncronized Intermittent Mandatory Ventilation
S/N	Serial Number
SW	Software

T

TM	Trademark
TV	Tidal Volume
TRM	Technical Reference Manual

U

UK	United Kingdom
URM	User´s Reference Manual
US	United States

V

VAC	Vacuum alt. Voltage Alternating Current
VBUS	Voltage Bus
VCV	Volume Controlled Ventilation
VDR	Voltage Dependent Resistor
Vol.	Volume

W

WGU	See A-WGU

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TECHNICAL DESCRIPTION A-AUF

General

The main part of the Frame pneumatics is built into the wall gas unit (A-WGU) and comprises:

- Pipeline gas inlets connections
- Yokes for gas cylinders (option)
- High pressure gauges for pipeline and cylinder pressure
- Oxygen flush pneumatics
- Scavenging outlet
- Scavenging ejector (option)
- Scavenging flow indicator (option)
- Auxiliary outlets for Air, O_2 and VAC (option)
- Non-return valves and safety valves

There are also pneumatic connections from the A-WGU unit to the Ventilator and Fresh gas control units as well as to the Bellows block via pneumatic connectors. All these connections are made on the left side of the Frame behind the side panels.

The Reservoir tube is located on a ”tray” which is accessible behind the side panels of the Frame.

Wall Gas Unit pneumatics

The Wall Gas unit can be of three versions A-WGU-00, A-WGU-01, A-WGU-02 and A-WGU-03

The main differences are:

- A-WGU-00
  - O_2 flush knob mounted in the A-WGU.
  - Maximum O_2 flush flow 25l/min.
  - No Air yoke option available.
- A-WGU-01
  - O_2 flush valve mounted either in the A-WGU or at the Frame Table
  - Maximum O_2 flush flow 50l/min.
- A-WGU-02
  - O_2 flush valve mounted either in the A-WGU or at the Frame Table
  - Maximum O_2 flush flow 50l/min.
  - White D-O color
- A-WGU-03
  - O_2 flush valve mounted at the frame table
  - Maximum O_2 flush flow 50l/min.

A-AUF pneumatic drawings and technical description of the Wall Gas Unit

Pneumatic drawings

There are four different pneumatic drawings that can be followed during the technical description of the Wall Gas Unit.

- A-WGU mounted Oxygen flush without Fresh Gas Flow Indicator
- A-WGU mounted Oxygen flush with Fresh Gas Flow Indicator

- Table mounted Oxygen flush without Fresh Gas Flow Indicator
- Table mounted Oxygen flush with Fresh Gas Flow Indicator

The A-WGU pneumatic drawings are divided into the following sections:

Section A -Central inlets

Section B - Reserve gas inlets

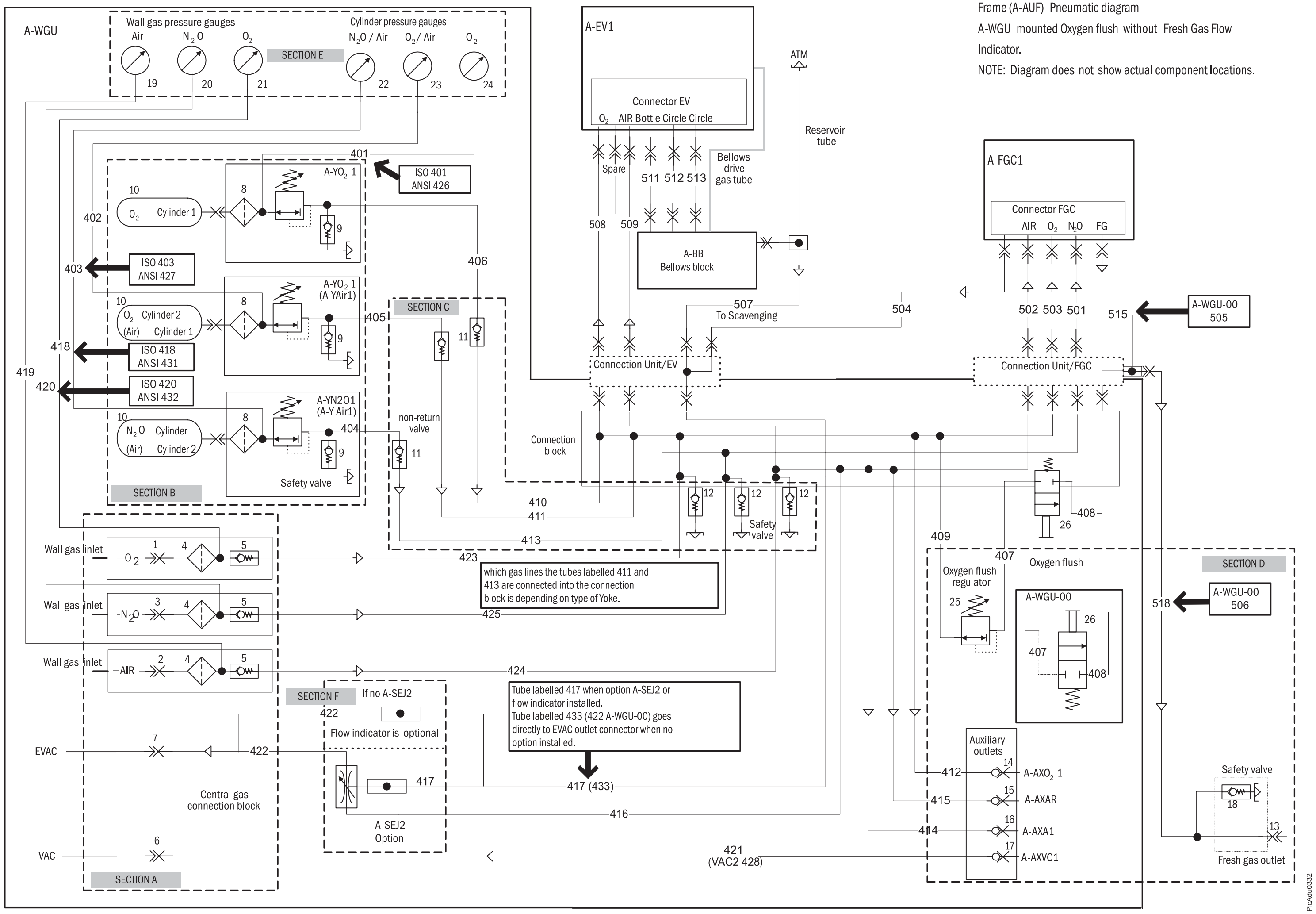
Section C - Gas distribution

Section D - Gas outlets, O_2 flush valve and fresh gas flow indicator

Section E - Pressure gauges

Section F - Scavenging ejector

A-WGU mounted oxygen flush without fresh gas flow indicator


A-WGU
Wall gas pressure gauges
Air
N2O
O2
SECTION E
Cylinder pressure gauges
N2O / Air
O2 / Air
O2
19
20
21
22
23
24
401
ISO 401
ANSI 426
A-YO2 1
10
8
O2
Cylinder 1
9
402
403
ISO 403
ANSI 427
10
8
A-YO2 1
(A-YAir1)
O2 Cylinder 2
(Air) Cylinder 1
9
405
418
ISO 418
ANSI 431
419
420
ISO 420
ANSI 432
A-YN2O1
(A-Y Air1)
10
8
N2O Cylinder
(Air) Cylinder 2
404
9
Safety valve
SECTION B
406
SECTION C
11
non-return valve
11
Connection block
410
411
413
12
12
12
Safety valve
Wall gas inlet
O2
1
4
5
423
Wall gas inlet
N2O
3
4
5
425
Wall gas inlet
AIR
2
4
5
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
422
417
417 (433)
Central gas connection block
A-SEJ2
Option
416
VAC
6
421
(VAC2 428)
SECTION A
A-EV1
Connector EV
O2 AIR Bottle Circle Circle
Spare
511 512 513
Bellows drive gas tube
ATM
Reservoir tube
508
509
A-BB
Bellows block
507
To Scavenging
Connection Unit/EV
A-FGC1
Connector FGC
AIR O2 N2O FG
504
502 503 501
515
A-WGU-00
505
Connection Unit/FGC
26
408
409
407
Oxygen flush regulator
Oxygen flush
25
A-WGU-00
26
407
408
SECTION D
A-WGU-00
506
518
Auxiliary outlets
14
412
A-AXO2 1
15
415
A-AXAR
16
414
A-AXA1
17
A-AXVC1
Safety valve
18
13
Fresh gas outlet
PicAdu0332

Frame (A-AUF) Pneumatic diagram

A-WGU mounted Oxygen flush without Fresh Gas Flow Indicator.

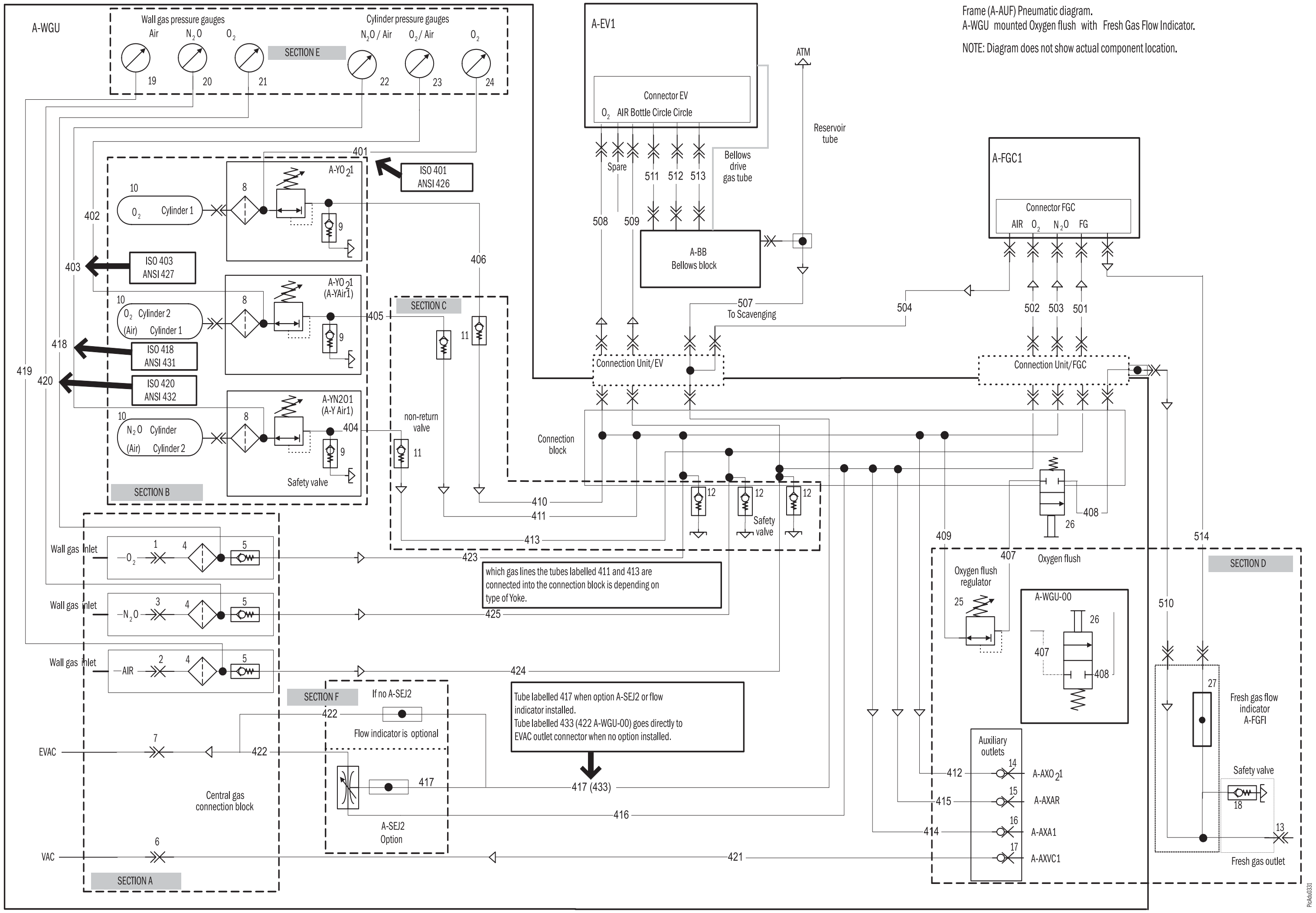
NOTE: Diagram does not show actual component locations.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed.
Tube labelled 433 (422 A-WGU-00) goes directly to EVAC outlet connector when no option installed.

Figure 1 A-WGU mounted oxygen flush without fresh gas flow indicator

A-WGU mounted oxygen flush with fresh gas flow indicator


Frame (A-AUF) Pneumatic diagram.
A-WGU mounted Oxygen flush with Fresh Gas Flow Indicator.

NOTE: Diagram does not show actual component location.

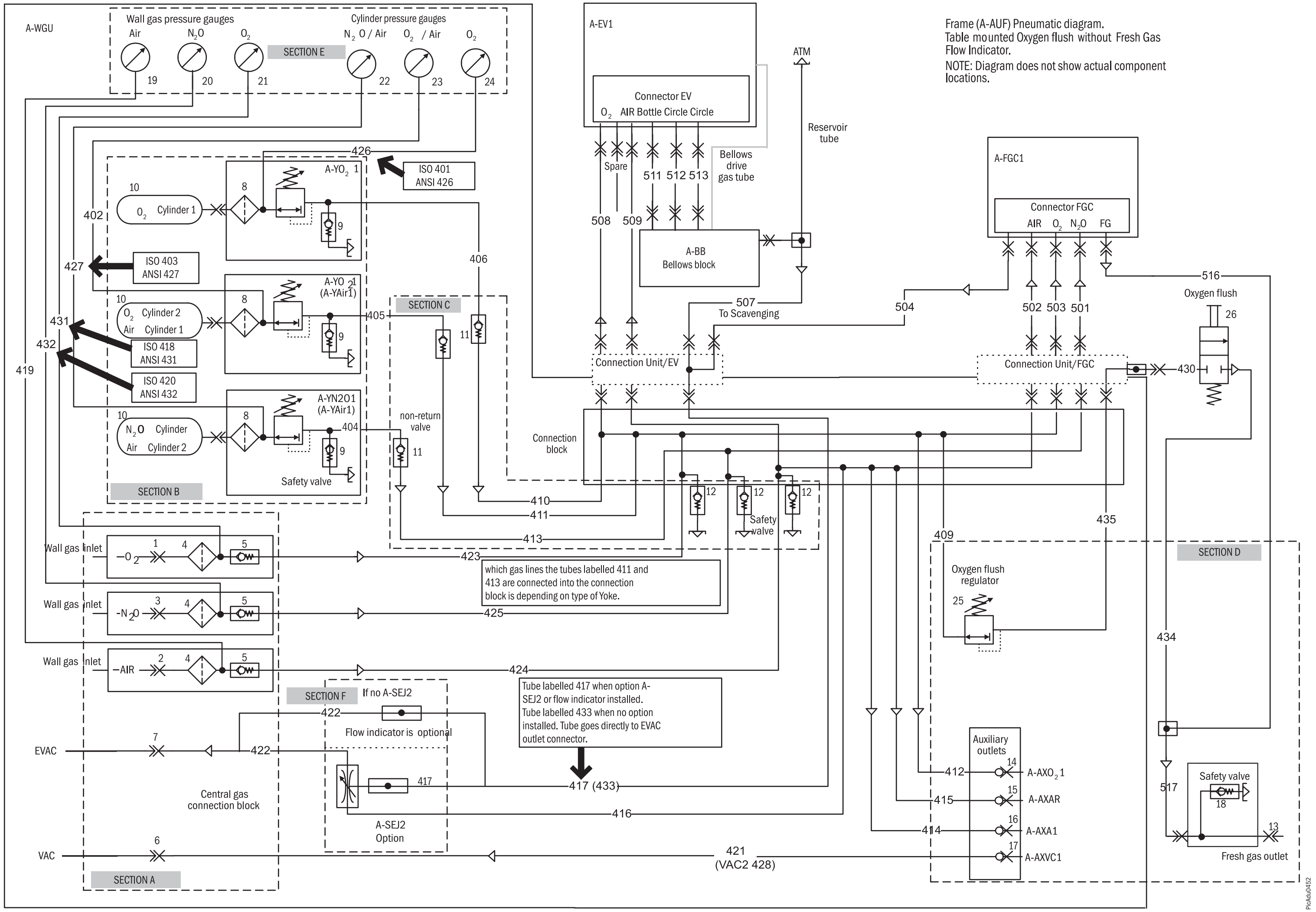
which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed.
Tube labelled 433 (422 A-WGU-00) goes directly to EVAC outlet connector when no option installed.

A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
Cylinder pressure gauges
N_2O / Air
O_2/ Air
O_2
SECTION E
19
20
21
22
23
24
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
Spare
511 512 513
508 509
Bellows drive gas tube
Reservoir tube
ATM
A-BB
Bellows block
507
To Scavenging
504
A-FGC1
Connector FGC
AIR O_2 N_2O FG
502 503 501
Connection Unit/EV
Connection Unit/FGC
401
ISO 401
ANSI 426
A-YO21
10
O_2 Cylinder 1
8
9
402
403
ISO 403
ANSI 427
406
A-YO21
(A-YAir1)
O_2 Cylinder 2
(Air) Cylinder 1
405
SECTION C
11
418
ISO 418
ANSI 431
419
420
ISO 420
ANSI 432
A-YN201
(A-Y Air1)
N_2O Cylinder
(Air) Cylinder 2
404
non-return valve
Safety valve
SECTION B
Connection block
410
411
413
12
Safety valve
26
408
409
407
Oxygen flush
Oxygen flush regulator
25
A-WGU-00
514
SECTION D
510
Wall gas inlet
O_2
1
4
5
423
N_2O
3
425
AIR
2
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
417
417 (433)
416
A-SEJ2
Option
Central gas connection block
VAC
6
421
SECTION A
Auxiliary outlets
412
14
A-AXO21
415
15
A-AXAR
414
16
A-AXA1
17
A-AXVC1
27
Fresh gas flow indicator
A-FGFI
Safety valve
18
13
Fresh gas outlet

Figure 2 A-WGU mounted oxygen flush with fresh gas flow indicator

Table mounted oxygen flush without fresh gas flow indicator


A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
SECTION E
Cylinder pressure gauges
N_2O / Air
O_2 / Air
O_2
19
20
21
22
23
24
426
ISO 401
ANSI 426
A-YO_2 1
10
O_2 Cylinder 1
8
9
402
ISO 403
ANSI 427
427
406
A-YO 2 1
(A-YAir1)
10
O_2 Cylinder 2
Air Cylinder 1
405
SECTION C
11
431
ISO 418
ANSI 431
432
ISO 420
ANSI 432
419
A-YN2O1
(A-YAir1)
N_2O Cylinder
Air Cylinder 2
404
non-return valve
Safety valve
SECTION B
Connection block
410
411
413
12
Safety valve
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
ATM
Reservoir tube
Spare
Bellows drive gas tube
511 512 513
508
509
A-BB
Bellows block
507
To Scavenging
504
Connection Unit/EV
A-FGC1
Connector FGC
AIR O_2 N_2O FG
502 503 501
516
Oxygen flush
26
Connection Unit/FGC
430
Wall gas inlet
$-O_2$
1
4
5
423
Wall gas inlet
$-N_2O$
3
425
Wall gas inlet
–AIR
2
424
SECTION F
If no A-SEJ2
422
Flow indicator is optional
417
A-SEJ2
Option
417 (433)
416
EVAC
7
Central gas connection block
VAC
6
421
(VAC2 428)
SECTION A
409
435
SECTION D
Oxygen flush regulator
25
434
Auxiliary outlets
412
415
414
14
15
16
17
A-AXO_2 1
A-AXAR
A-AXA1
A-AXVC1
517
Safety valve
18
13
Fresh gas outlet
PoAdu0452

Frame (A-AUF) Pneumatic diagram.
Table mounted Oxygen flush without Fresh Gas Flow Indicator.

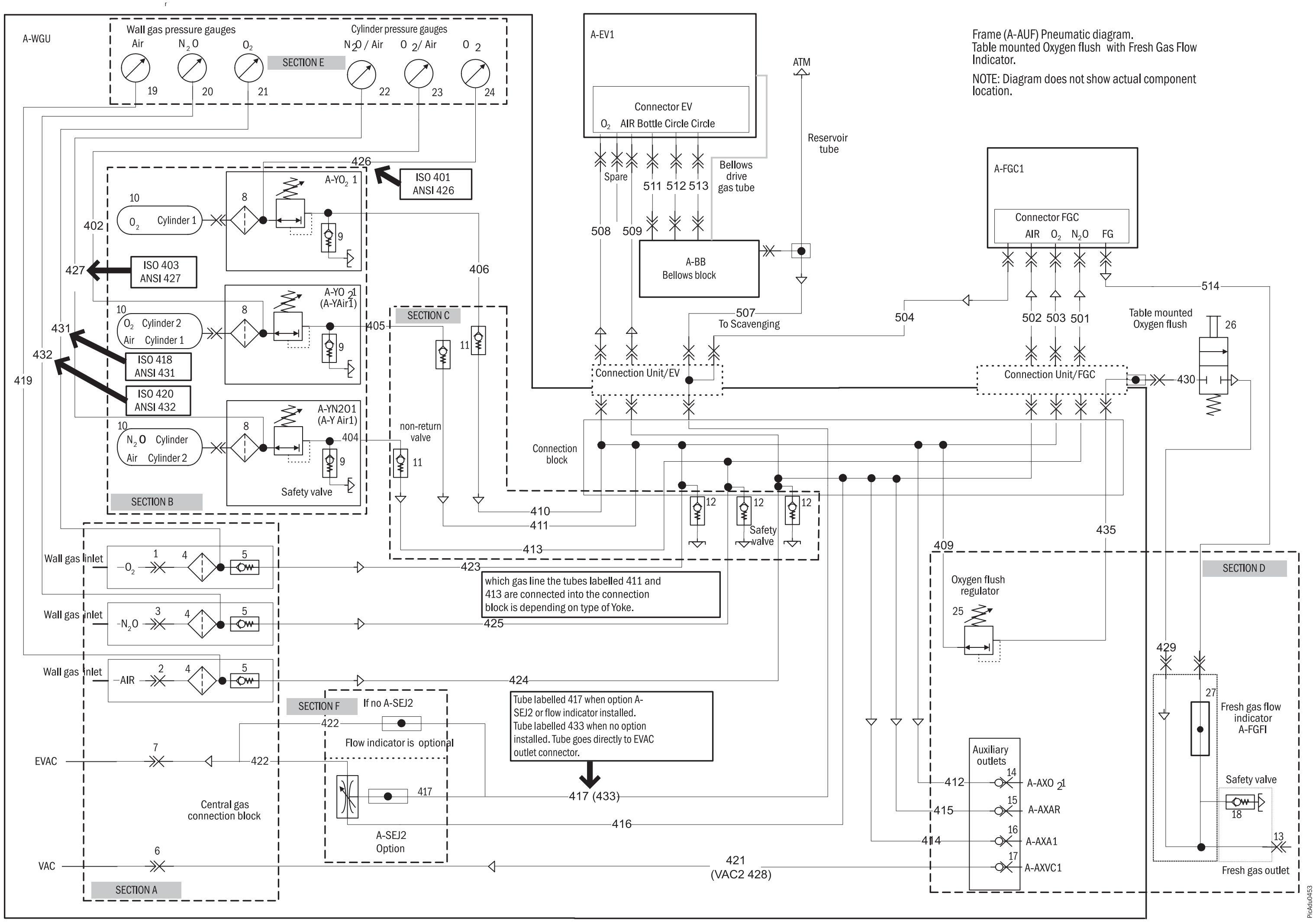
NOTE: Diagram does not show actual component locations.

which gas lines the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed. Tube labelled 433 when no option installed. Tube goes directly to EVAC outlet connector.

Figure 3 Table mounted oxygen flush without fresh gas flow indicator

Table mounted oxygen flush with fresh gas flow indicator


A-WGU
Wall gas pressure gauges
Air
N_2O
O_2
Cylinder pressure gauges
N_2O / Air
O_2/ Air
O_2
SECTION E
19
20
21
22
23
24
A-EV1
Connector EV
O_2 AIR Bottle Circle Circle
Spare
511 512 513
Bellows drive gas tube
508
509
A-BB
Bellows block
ATM
Reservoir tube
507
To Scavenging
504
A-FGC1
Connector FGC
AIR O_2 N_2O FG
502 503 501
514
Table mounted Oxygen flush
26
430
Connection Unit/EV
Connection Unit/FGC
426
ISO 401
ANSI 426
A-YO_2 1
10
O_2 Cylinder 1
8
9
402
406
427
ISO 403
ANSI 427
A-YO 21
(A-YAir1)
O_2 Cylinder 2
Air Cylinder 1
405
SECTION C
11
431
ISO 418
ANSI 431
432
ISO 420
ANSI 432
419
A-YN2O1
(A-Y Air1)
N_2O Cylinder
Air Cylinder 2
404
non-return valve
Safety valve
SECTION B
Connection block
410
411
413
12
Safety valve
409
435
Wall gas inlet
O_2
1
4
5
423
Wall gas inlet
N_2O
3
425
Wall gas inlet
AIR
2
424
SECTION D
Oxygen flush regulator
25
429
27
Fresh gas flow indicator
A-FGFI
Safety valve
18
13
Fresh gas outlet
SECTION F
If no A-SEJ2
422
Flow indicator is optional
EVAC
7
422
417
417 (433)
416
A-SEJ2
Option
Central gas connection block
Auxiliary outlets
412
14
A-AXO 21
415
15
A-AXAR
414
16
A-AXA1
17
A-AXVC1
VAC
6
421
(VAC2 428)
SECTION A
PicAdu0453

Frame (A-AUF) Pneumatic diagram.
Table mounted Oxygen flush with Fresh Gas Flow Indicator.

NOTE: Diagram does not show actual component location.

which gas line the tubes labelled 411 and 413 are connected into the connection block is depending on type of Yoke.

Tube labelled 417 when option A-SEJ2 or flow indicator installed. Tube labelled 433 when no option installed. Tube goes directly to EVAC outlet connector.

Figure 4 Table mounted oxygen flush with fresh gas flow indicator

Technical description of the Wall Gas Unit

Pipeline inlets

See Section A in pneumatic drawings.

There are pipeline gas inlets for O_2 (1), Air (2) and N_2O (3).

Each inlet consists of:

- Connector (inlet)
- Hose nipple connector (outlet)
- Sinter filter (4)
- Non-return valve (5)
- The non-return valve prevents spare cylinder from exhausting itself into the central system when the cylinders are used as gas supply.

There are also connections for vacuum VAC (6) and evacuation EVAC (7). These connectors consist of hose nipple.

Reserve gas inlets (Yokes)

See Section B in pneumatic drawings.

Reserve gas supply inlets (O_2 and Air N_2O) for the ADU are optional. Three cylinder inlets are the maximum that can be installed.

Available cylinder inlet combinations		
O_2	O_2	Air
O_2	O_2	N_2O
O_2	Air	Air
O_2	Air	N_2O

NOTE: Available combinations are country specific.

NOTE: Wall Gas Unit version 00 have not Air Yoke as option.

Each reserve gas supply consists of:

- Cylinder (10) (provided by customer)
- Yoke with sinter filter (8), pressure reduction valve, includes safety valves, 7 bar (9).

Gas distribution

See Section C in pneumatic drawings.

This section distributes input gas from pipeline inlets and reserve gas cylinders to the A-WGU. There are non-return valve (11) to prevent back filling of the cylinders. Safety valves (12) for input gas is mounted on the gas connection block in the WGU.

Gas outlets and O_2 flush valve

See Section D in pneumatic drawings

There is a gas outlet for the fresh gas for a patient (13) and optional extra gas outlets for O_2 (14), Air (15,16) and vacuum (17).

The fresh gas outlet remains open when the connector is released. Extra gas outlets are closed, if the connector is released.

There is also a safety valve for fresh gas (18).

Some units are equipped with fresh gas flow indicator A-FGFI (27).

An adjustable flush regulator (25) reduces the oxygen input to the O_2 flush valve (26), which is an On/Off type of valve. The O_2 flush valve delivers a high O_2 flow to the patient system, bypassing the fresh gas control unit.

Pressure gauges

See Section E in pneumatic drawings.

There are pressure gauges for central pipeline inlets (19, 20 and 21) and for reserve gas cylinders (22,23 and 24).

Scavenging ejector

See Section F in pneumatic drawings.

The scavenging system is needed to avoid pollution of the user environment and to take care of waste gases coming from the breathing system and fresh gas control unit.

Where there is no external active scavenging system to be connected to the EVAC outlet (7), an built in ejector is provided as option. There are two types of ejector, depending on A-WGU version. The A-SEJ1 ejector was as manufacturing built into wall gas unit A-WGU-00. The ejector A-SEJ2 is built in to fit A-WGU-01. The A-SEJ2 ejector includes a flow indicator and it is possible to install in A-WGU-00 in the field.

A-WGU-00, tubing and component location (ISO Version)

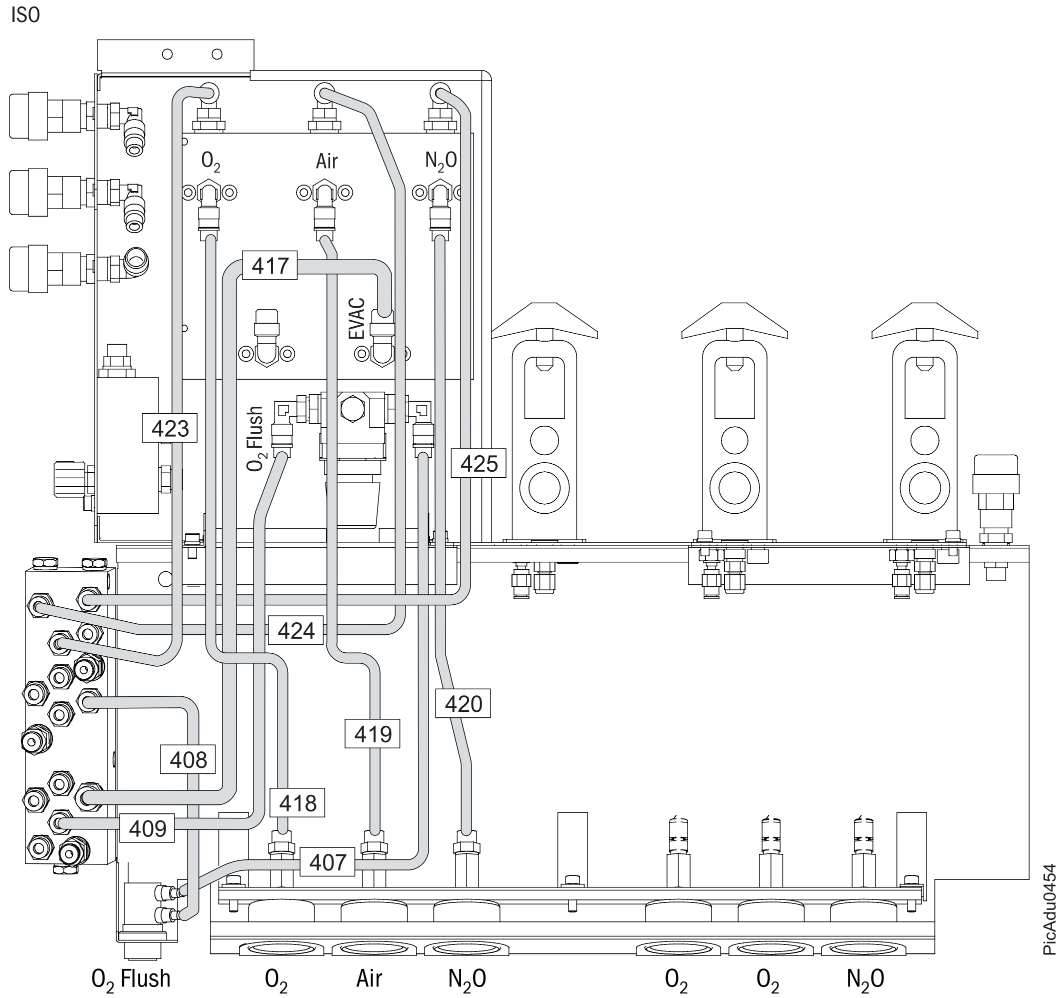

ISO
O_2
Air
N_2O
417
EVAC
423
O_2 Flush
425
424
420
419
408
418
409
407
PicAdu0454
O_2 Flush
O_2
Air
N_2O
O_2
O_2
N_2O

Figure 5 Wall Gas Unit A-WGU-00, tubing and component location (ISO Version)

A-WGU-00, option (ISO Version)

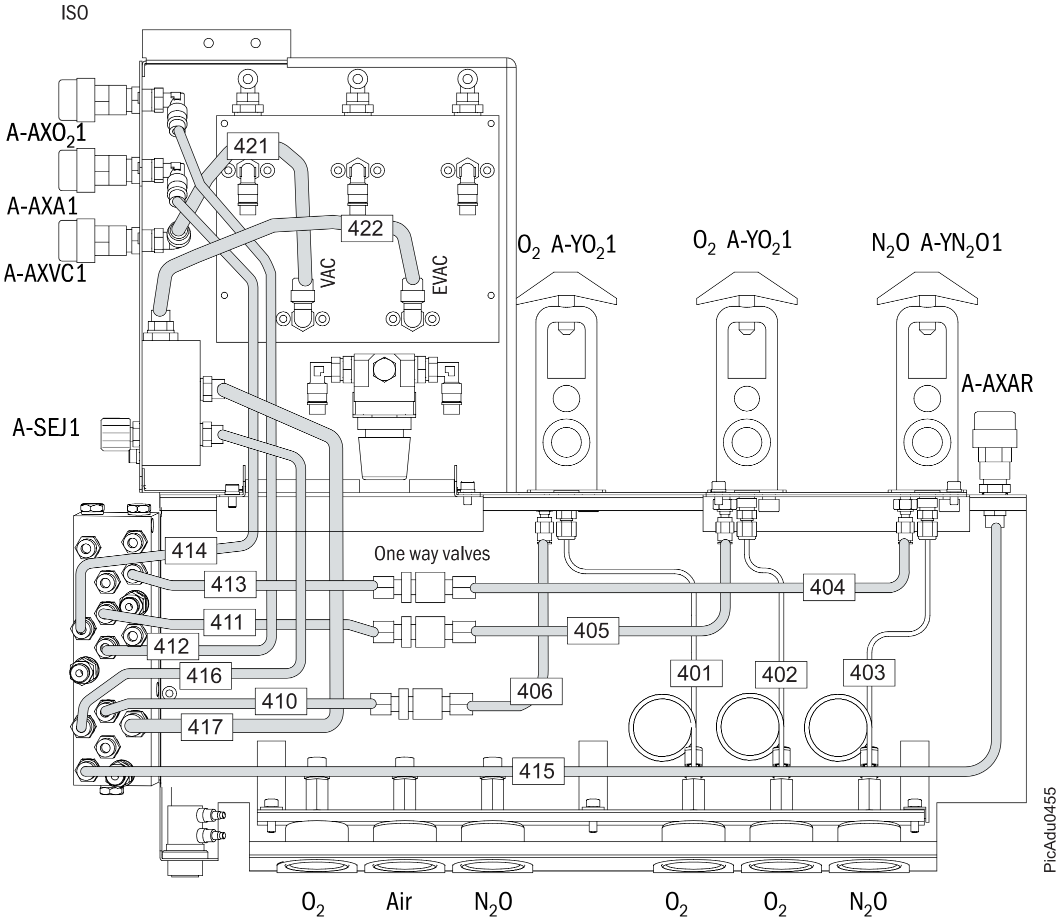

ISO
A-AXO$_2$1
A-AXA1
A-AXVC1
421
422
VAC
EVAC
O$_2$ A-YO$_2$1
O$_2$ A-YO$_2$1
N$_2$O A-YN$_2$O1
A-AXAR
A-SEJ1
414
One way valves
413
404
411
405
412
401
402
403
416
406
410
417
415
PicAdu0455
O$_2$
Air
N$_2$O
O$_2$
O$_2$
N$_2$O

Figure 6 Wall Gas Unit A-WGU-00, option (ISO Version)

Tubing connection chart A-WGU-00 (ISO versions)

Tube connected according to WGU tubing and component location (ISO version).

Wall Gas Unit, without options (ISO)				
Tube/Pipe No.	**Tube type**	**Length (mm)**	**From**	**To**
407	733472	340	O_2-Flush	Regulator
408	733472	370	O_2-Flush	Connection block -408
409	733472	390	Connection block-409	Regulator
418	733472	390	Wall gas connection-O_2	Manometer-O_2
419	733472	390	Wall gas connection-Air	Manometer-Air
420	733472	390	Wall gas connection-N_2O	Manometer-N_2O
422	733479	350	Wall gas connection-EVAC	Connection block-417
NOTE: For tube 422 this is valid if A-SEJ1 **not** is implemented				
423	733472	430	Wall gas connection-O_2	Connection block-423
424	733472	390	Wall gas connection-Air	Connection block-424
425	733472	430	Wall gas connection-N_2O	Connection block-425

Wall Gas Unit, with options (ISO)				
Tube/Pipe No.	**Tube type**	**Length (mm)**	**From**	**To**
401	72271	365	O_2-Yoke (1)	Manometer O_2-Yoke (1)
402	72271	311	O_2-Yoke (2)	Manometer O_2-Yoke (2)
403	72271	315	N_2O-Yoke	Manometer N_2O-Yoke
404	733472	350	N_2O-Yoke	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block-410
411	733472	160	Non-return valve	Connection block-411
412	733472	410	A-AXO21	Connection block-412
413	733472	180	Non-return valve	Connection block-413
414	733472	380	A-AXA1	Connection block-414
415	733472	620	A-AXAR	Connection block-415
416	733472	330	A-SEJ1	Connection block-416
417	733479	380	A-SEJ1	Connection block-417
421	733479	300	Wall gas connection-VAC	A-AXVC1
422	733479	350	Wall gas connection-EVAC	A-SEJ1

A-WGU-00, tubing and component location (ANSI version)

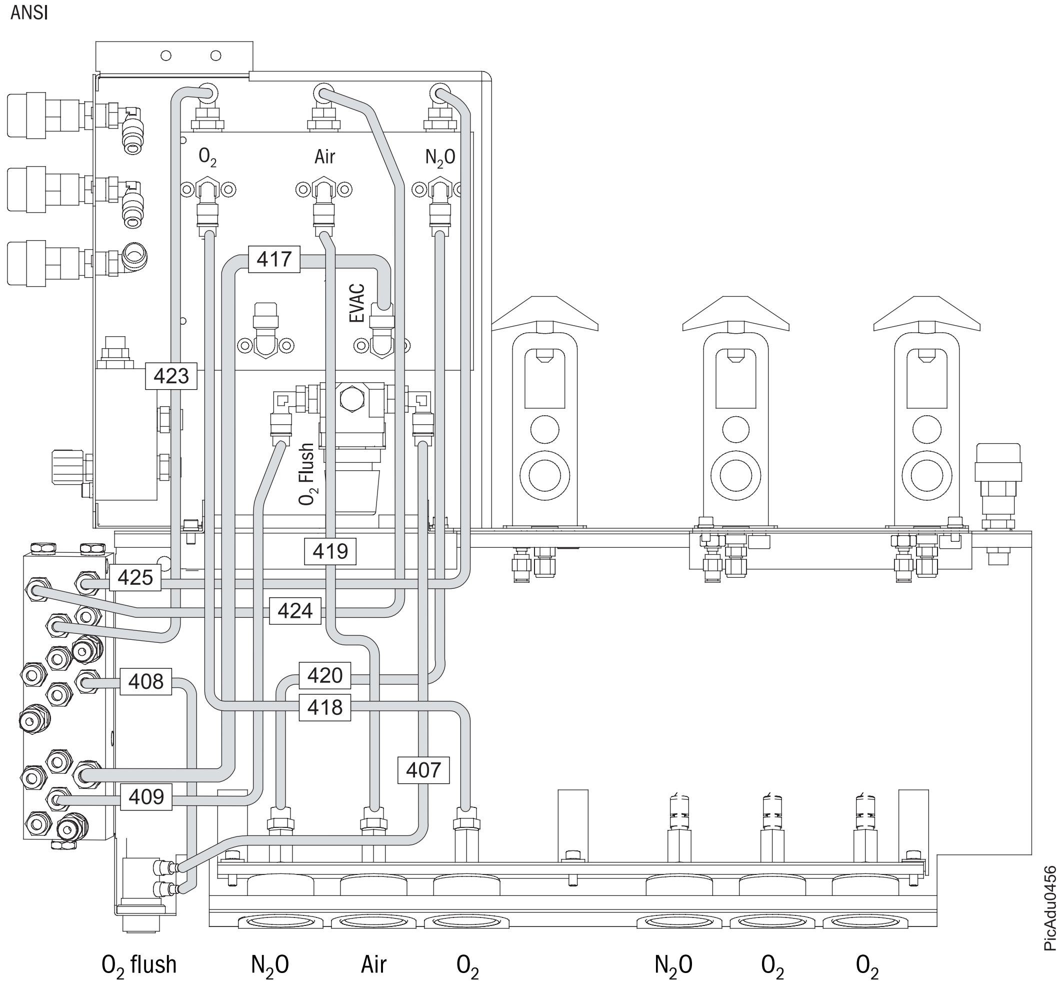

ANSI
O_2
Air
N_2O
417
EVAC
423
O_2 Flush
419
425
424
408
420
418
407
409
PicAdu0456
O_2 flush
N_2O
Air
O_2
N_2O
O_2
O_2

Figure 7 Wall Gas Unit A-WGU-00, tubing and component location (ANSI version)

A-WGU-00, option (ANSI version)

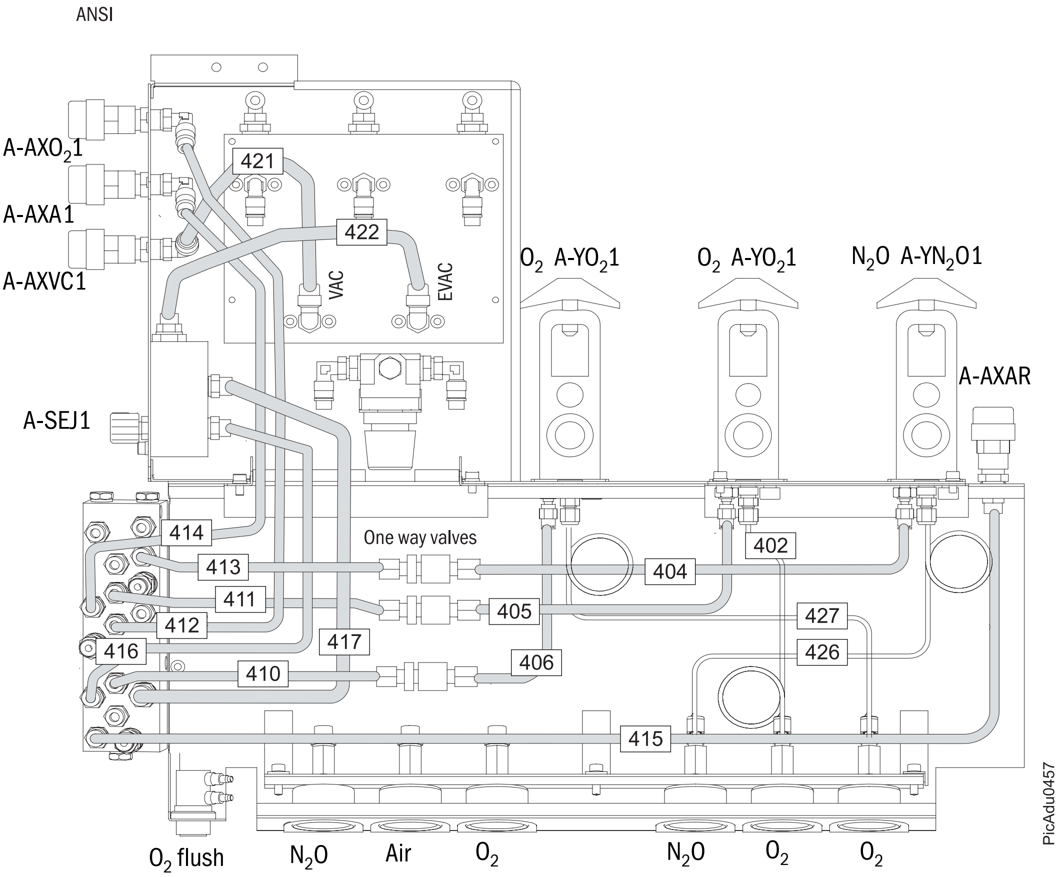

ANSI
A-AXO$_2$1
A-AXA1
A-AXVC1
A-SEJ1
421
422
VAC
EVAC
O$_2$ A-YO$_2$1
O$_2$ A-YO$_2$1
N$_2$O A-YN$_2$O1
A-AXAR
414
413
411
412
416
417
410
One way valves
404
402
405
406
427
426
415
O$_2$ flush
N$_2$O
Air
O$_2$
N$_2$O
O$_2$
O$_2$
PicAdu0457

Figure 8 Wall Gas Unit A-WGU-00, option (ANSI version)

Tubing connection chart (A-WGU-00 (ANSI versions)

Tubing connected according to wall gas unit tubing and component location.

Wall Gas Unit, without options (ANSI)

Tube/Pipe No.	Tube type	Length (mm)	From	To
407	733472	340	O_2-Flush	Regulator
408	733472	370	O_2-Flush	Connection block -408
409	733472	390	Connection block-409	Regulator
*418	733472	390	Wall gas connection-O_2	Manometer-O_2
419	733472	390	Wall gas connection-Air	Manometer-Air
*420	733472	390	Wall gas connection-N_2O	Manometer-N_2O
422	733479	350	Wall gas connection-EVAC	Connection block-417
NOTE: For tube 422 this is valid if A-SEJ1 **not** is implemented				
423	733472	430	Wall gas connection-O_2	Connection block-423
424	733472	390	Wall gas connection-Air	Connection block-424
425	733472	430	Wall gas connection-N_2O	Connection block-425

*) Differs from ISO-standard.

NOTE: Tubes 418 and 420 are cross-connected to respective manometer.

Wall Gas Unit, with options (ANSI)

Tube/Pipe No.	Type	Length (mm)	From	To
*426	72271	470	O_2-Yoke (1)	Manometer O_2-Yoke (1)
402	72271	311	O_2-Yoke (2)	Manometer O_2-Yoke (2)
*427	72271	440	N_2O-Yoke	Manometer N_2O-Yoke
404	733472	390	N_2O-Yoke	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	170	O_2-Yoke (1)	Non-return valve
410	733472	180	Non-return valve	Connection block-410
411	733472	160	Non-return valve	Connection block-411
412	733472	410	A-AXO21	Connection block-412
413	733472	130	Non-return valve	Connection block-413
414	733472	380	A-AXA1	Connection block-414
415	733472	620	A-AXAR	Connection block-415
416	733472	330	A-SEJ1	Connection block-416
417	733479	380	A-SEJ1	Connection block-417
421	733479	300	Wall gas connection-VAC	A-AXVC1
422	733479	350	Wall gas connection-EVAC	A-SEJ1

NOTE: Copper pipes 426 and 427 are cross connected to respective manometer.

A-WGU-01, -02, -03 without options. Tubing and component Location (ISO version)

ISO

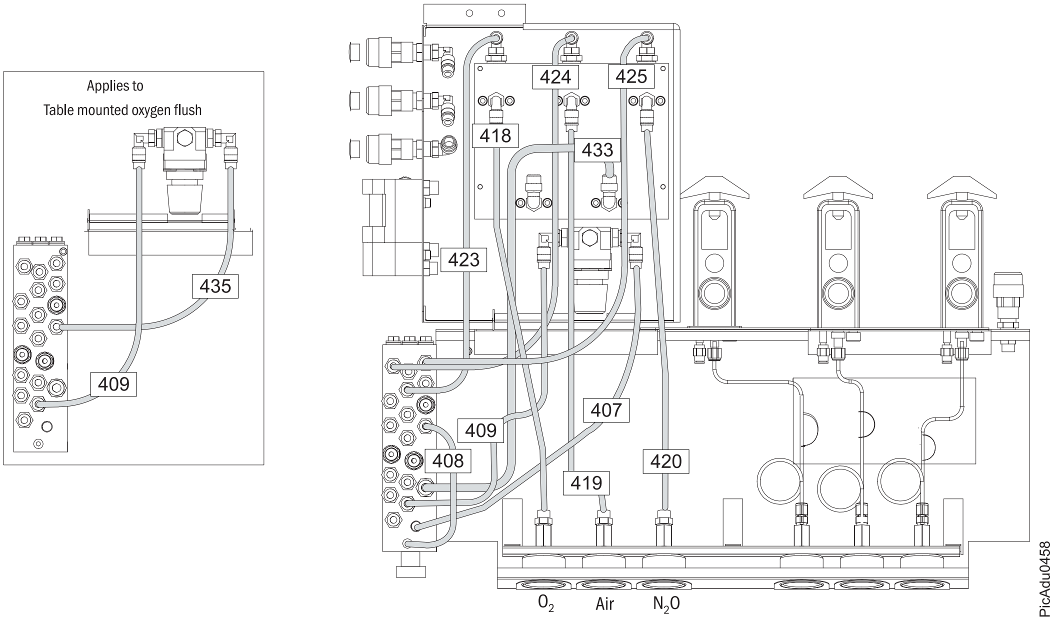


Figure 9 Wall gas unit A-WGU-01, -02, -03 Without Options tubing and component location (ISO version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
*407	733472	340	O_2 flush regulator	Connection block O_2-flush
#435	733472	270	O_2 flush regulator	Connection block O_2-flush
*408	733472	370	Connection block	Connection block
409	733472	300	Connection block –409	O_2 flush regulator
418	733472	390	Wall gas connection -O_2	Wall pressure gauge O_2
419	733472	390	Wall gas connection –Air	Wall pressure gauge Air
420	733472	390	Wall gas connection -N_2O	Wall pressure gauge N_2O
433	733479	350	Wall gas connection –EVAC	Connection block
423	733472	430	Wall gas connection -O_2	Connection block
424	733472	430	Wall gas connection –Air	Connection block
425	733472	430	Wall gas connection -N_2O	Connection block

*) Only applicable for units with A-WGU mounted Oxygen flush.

#) Only applicable for units with Table mounted Oxygen flush.

A-WGU-01, -02, -03 without options. Tubing and component location (ANSI version)

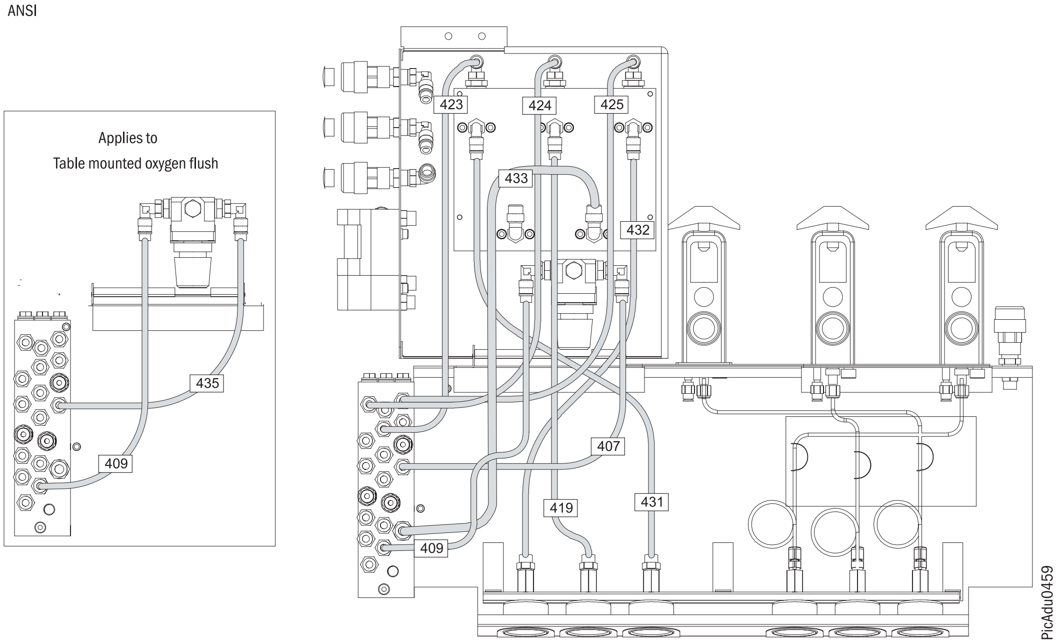


Figure 10 Wall gas unit A-WGU-01, -02, -03 Without options tubing and component location (ANSI version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
*407	733472	340	O_2 flush regulator	Connection block O_2-flush
#435	733472	270	O_2 flush regulator	Connection block O_2-flush
*408	733472	370	Connection block	Connection block
409	733472	300	Connection block	O_2 flush Regulator
431	733472	430	Wall gas connection -O_2	Wall pressure gauge O_2
419	733472	390	Wall gas connection -Air	Wall pressure gauge Air
432	733472	430	Wall gas connection -N_2O	Wall pressure gauge N_2O
425	733472	430	Wall gas connection -N_2O	Connection block
423	733472	430	Wall gas connection -O_2	Connection block
424	733472	430	Wall gas connection -Air	Connection block
433	733479	350	Wall gas connection -EVAC	Connection block

*) Only applicable for units with A-WGU mounted Oxygen flush.

#) Only applicable for units with Table mounted Oxygen flush.

A-WGU-01, -02, -03 extra gas outlets option

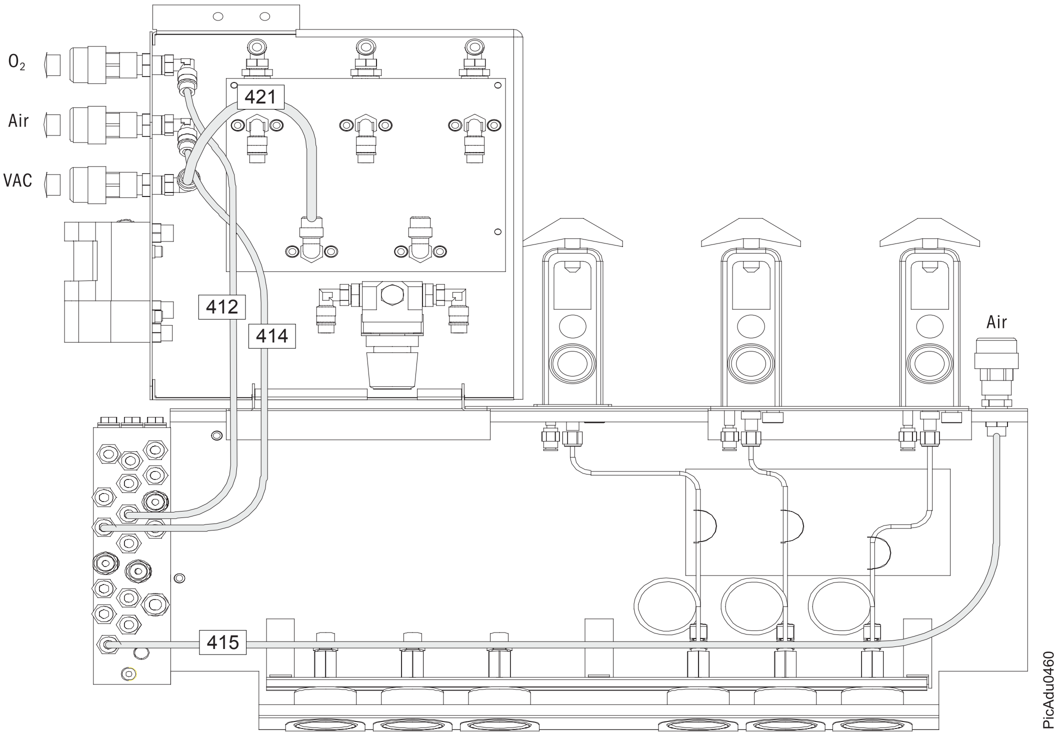


Figure 11 Wall Gas Unit A-WGU-01, -02, -03 extra gas outlets option

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
412	733472	410	A-AXO21	Connection block
414	733472	380	A-AXA1	Connection block
415	733472	620	A-AXAR	Connection block
421	733479	300	Wall gas connection VAC	A-AXVC1

A-WGU-01, -02, -03 vacuum Vac2 outlet option

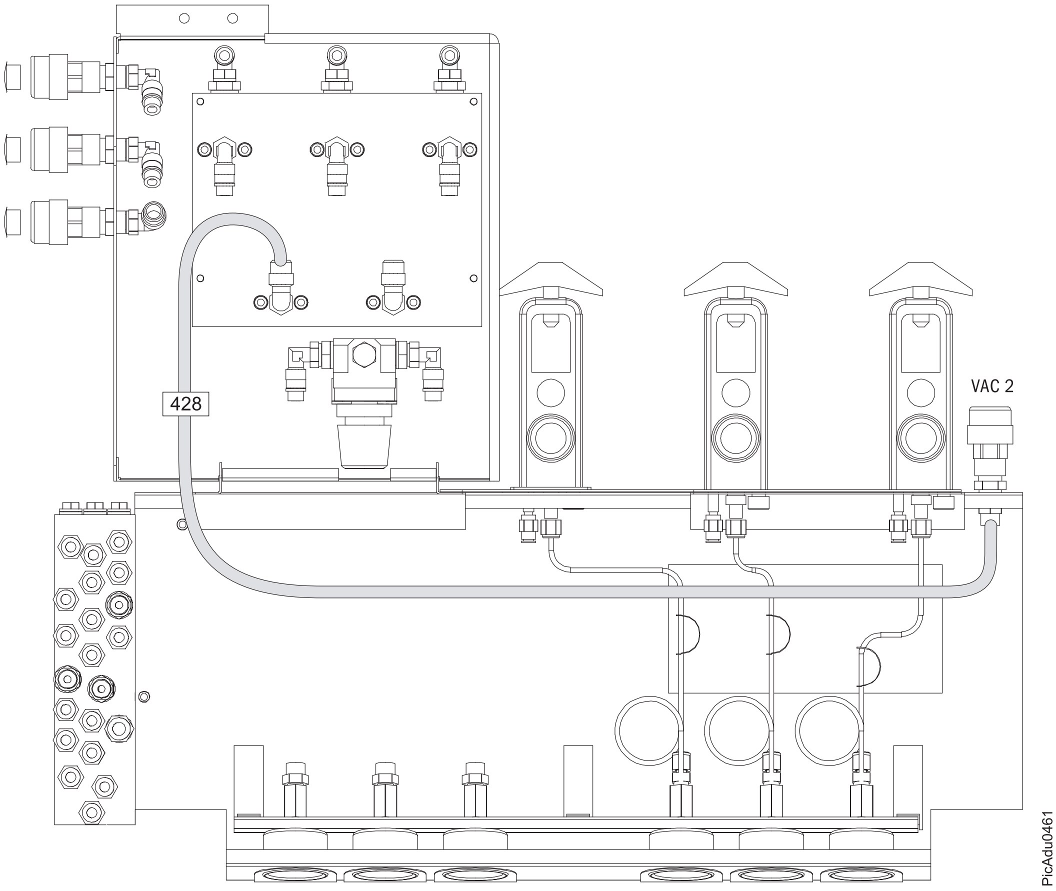


Figure 12 **Wall Gas Unit AWGU-01, -02, -03 vacuum Vac2 outlet option**

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
428	733479	750	Wall gas connection-VAC	A-AXVCR

A-WGU-01,-02, -03 with double Vac outlets option

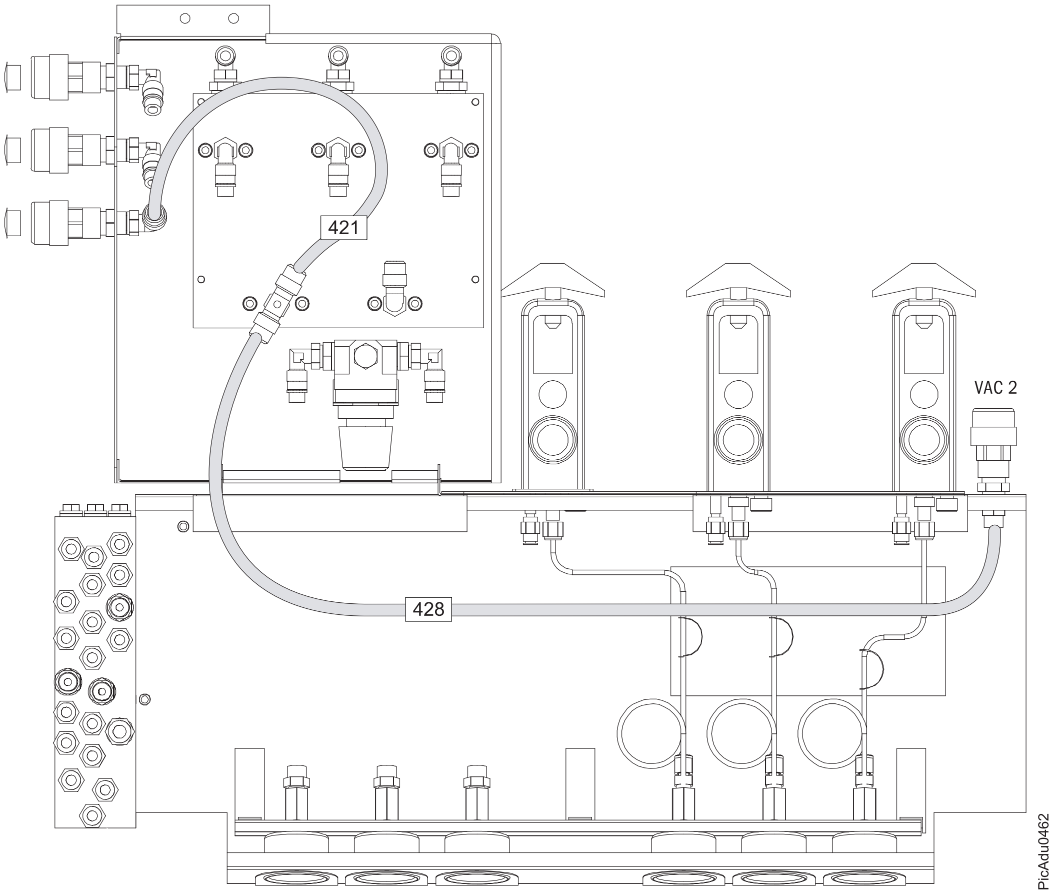


Figure 13 Wall Gas Unit A-WGU-01,-02, -03 with double Vac outlets option

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
428	733479	750	T-connector	Vac2 (A-AXVCR)
421	733479	300	T-connector	Vac (A-AVC1)

A-WGU-01,-02,-03 with scavenging flow indicator attached

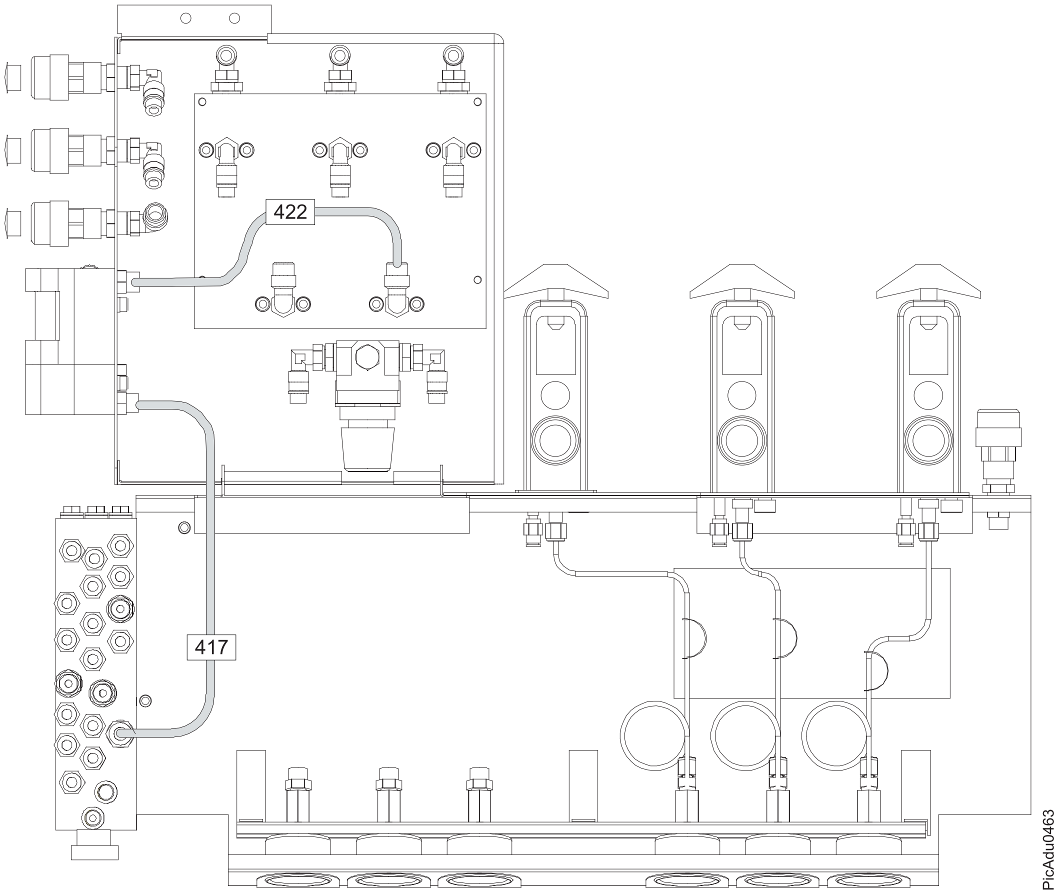


Figure 14 Wall Gas Unit A-WGU-01,-02,-03 with scavenging flow indicator attached

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
417	733479	380	Flow indicator	Connection block
422	733479	175	Wall gas connection EVAC	Flow indicator

A-WGU-01, -02, -03 with scavenging ejector attached

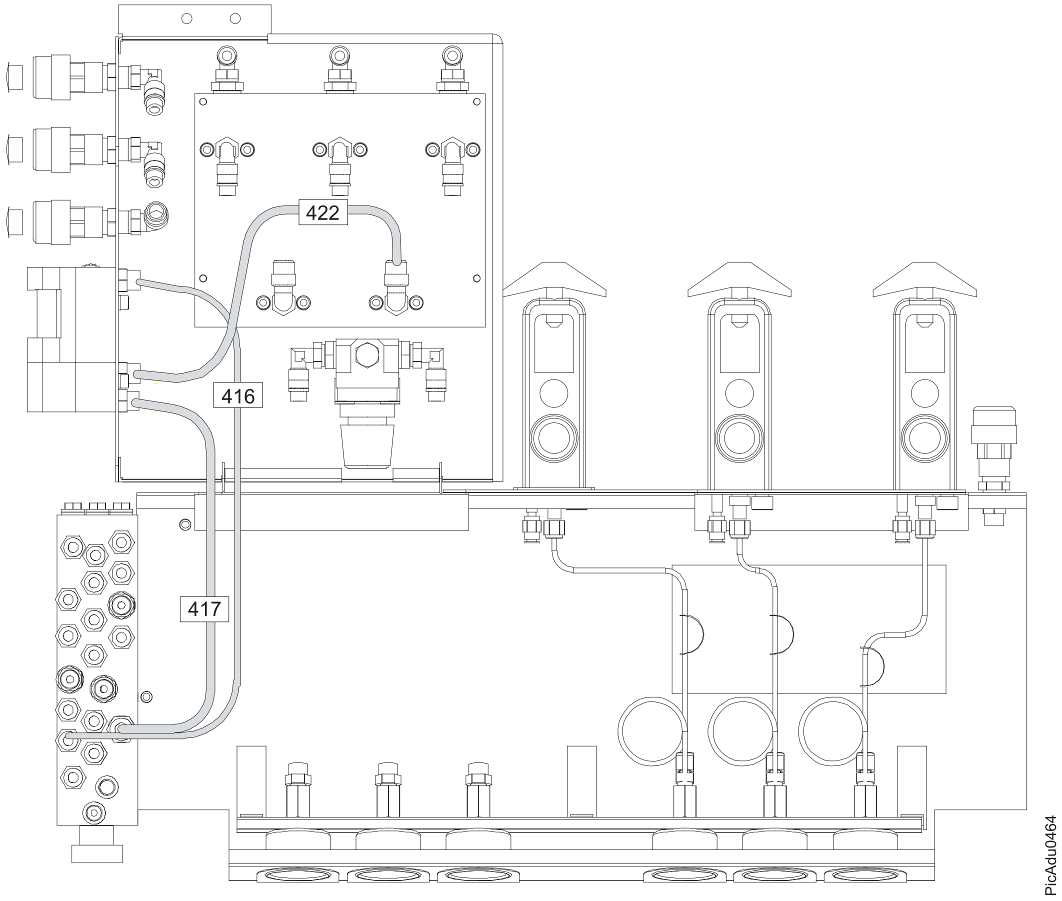


Figure 15 **Wall gas unit A-WGU-01, -02, -03 with scavenging ejector attached**

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
416	733472	390	A-SEJ2 (incl. Flow indicator)	Connection block
417	733479	380	A-SEJ2 (incl. Flow indicator)	Connection block
422	733479	175	Wall gas connection EVAC	A-SEJ2 (incl. Flow indicator)

A-WGU-01, -02, -03 gas cylinder option O_2+ O_2 + Air (ISO version)

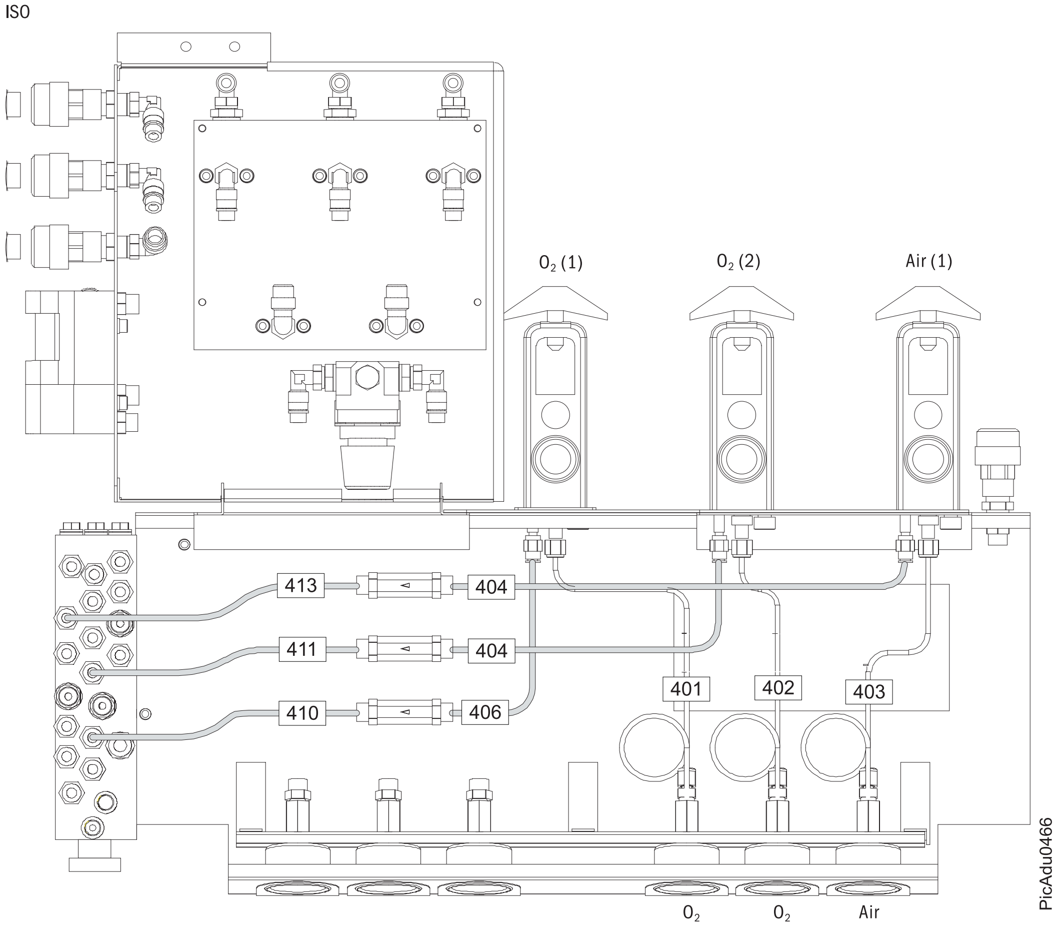


Figure 16 A-WGU-01, -02, -03 gas cylinder option O_2 + O_2 + Air (ISO version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
401	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
402	72271	pipe	O_2-Yoke (2)	O_2-Yoke pressure gauge
403	72271	pipe	Air-Yoke (1)	Air-Yoke pressure gauge
404	733472	350	Air-Yoke (1)	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + O_2 + Air (ANSI version)

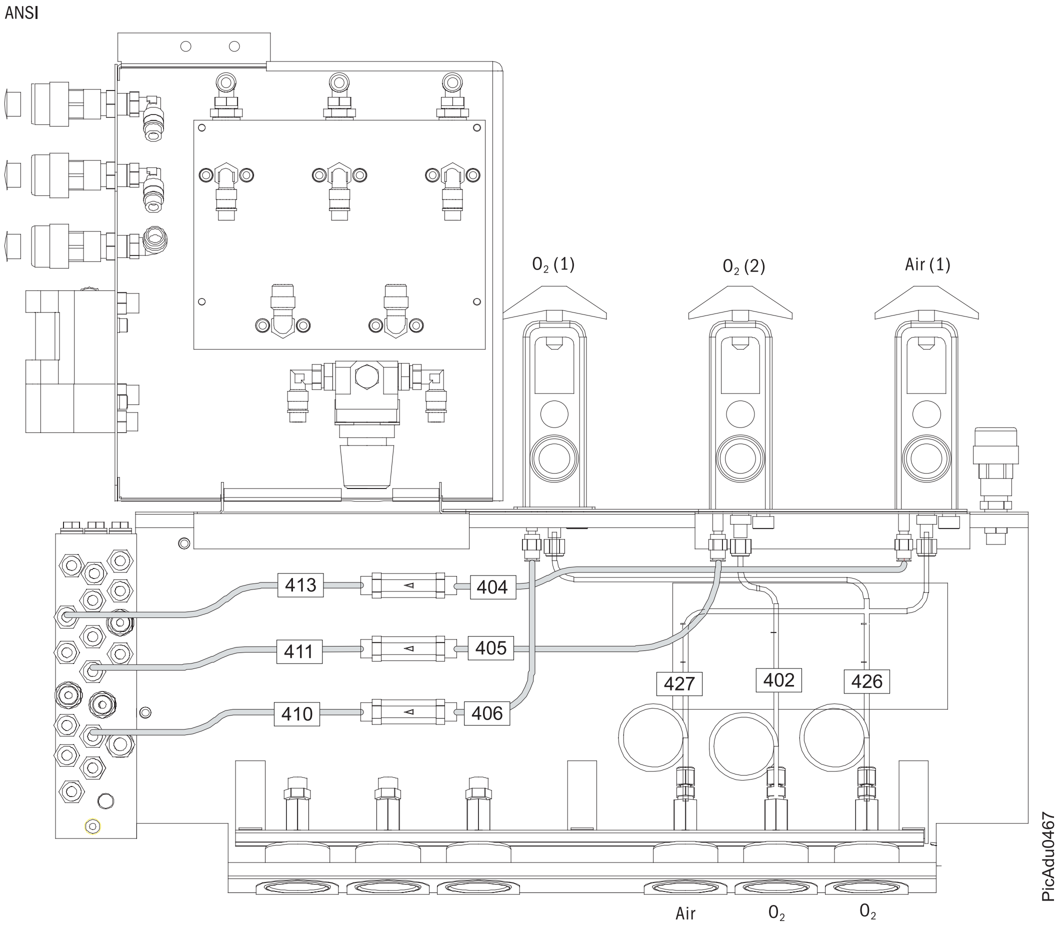


Figure 17 A-WGU-01, -02, -03, gas cylinder option O_2 + O_2 + Air (ANSI version)

Tubing / Pipe data

No.	Type	Length (mm)	Routed from	Routed to
402	72271	pipe	O_2-Yoke (2)	O_2-Yoke pressure gauge
426	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
427	72271	pipe	Air-Yoke (1)	Air-Yoke pressure gauge
404	733472	350	Air-Yoke (1)	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03, gas cylinder option O_2 + O_2 + N_2O (ISO version)

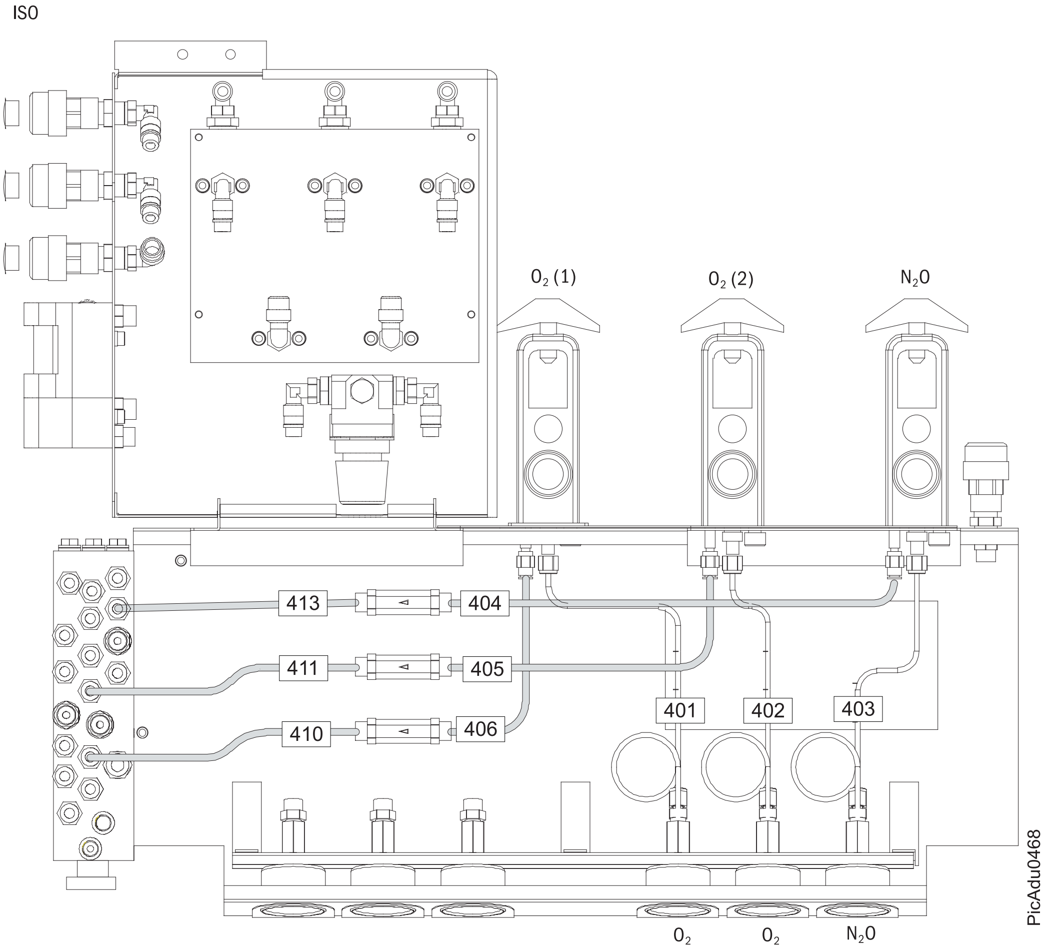


Figure 18 A-WGU-01, -02, -03, gas cylinder option O_2 + O_2 + N_2O (ISO version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
401	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
402	72271	pipe	O_2-Yoke (2)	O_2-Yoke pressure gauge
403	72271	pipe	N_2O-Yoke	N_2O-Yoke pressure gauge
404	733472	350	N_2O-Yoke	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + O_2 + N_2O (ANSI version)

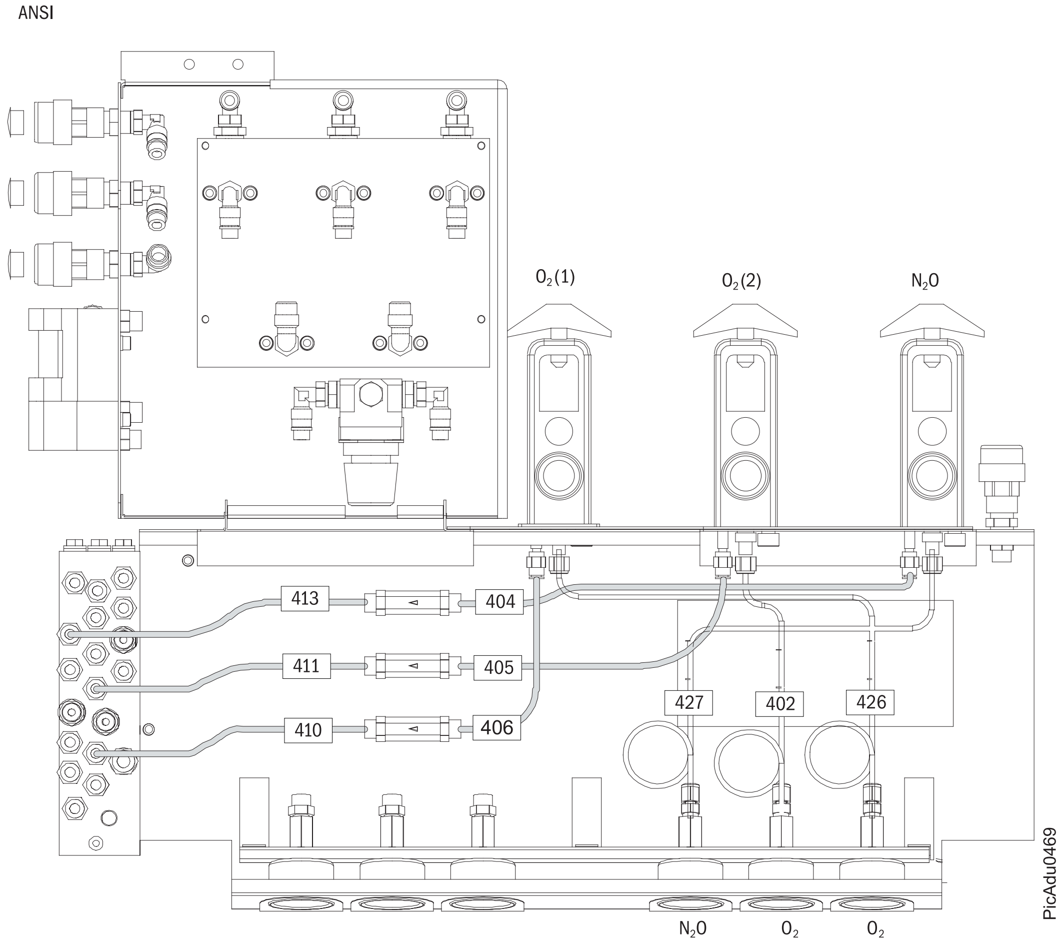


Figure 19 A-WGU-01, -02, -03, gas cylinder option O_2 + O_2 + N_2O (ANSI version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
402	72271	pipe	O_2-Yoke (2)	O_2-Yoke pressure gauge
426	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
427	72271	pipe	N_2O-Yoke	N_2O-Yoke pressure gauge
404	733472	350	Air-Yoke (1)	Non-return valve
405	733472	260	O_2-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + Air + Air (ISO version)

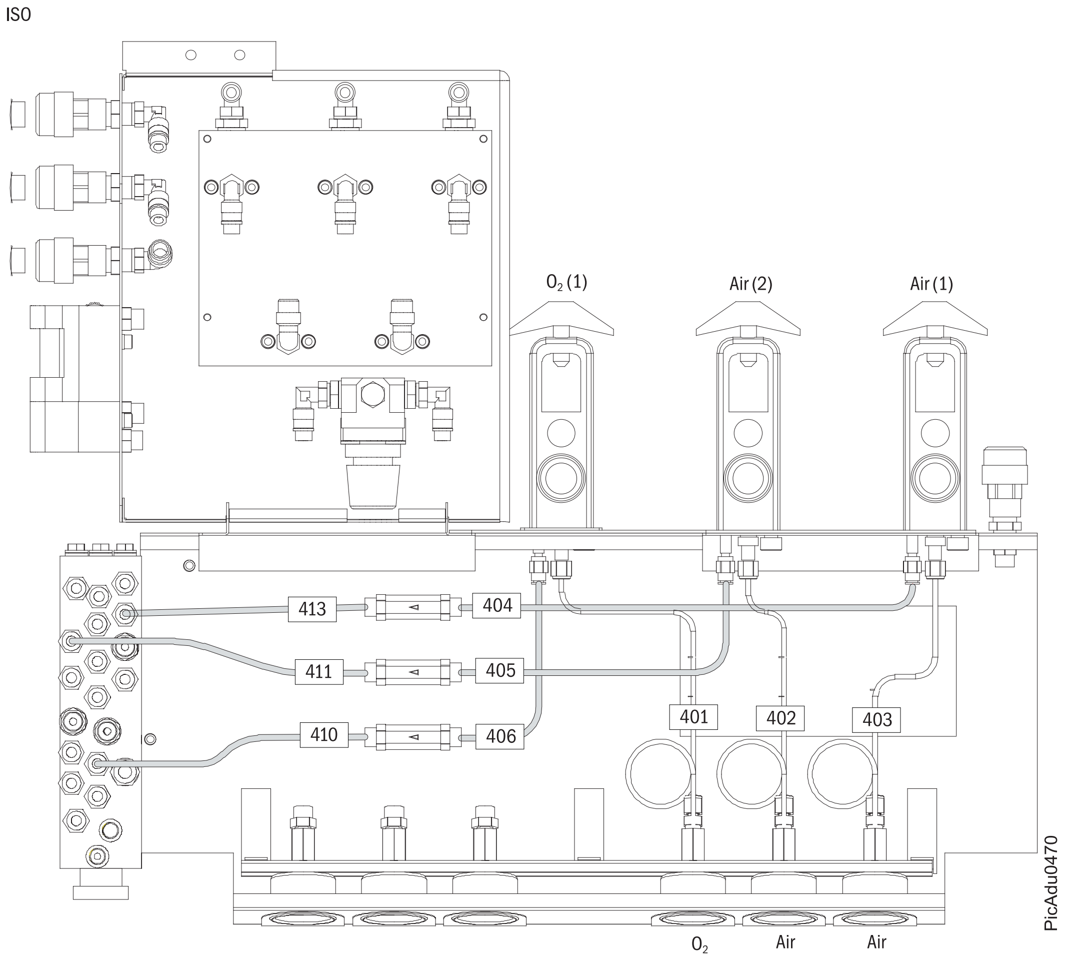

ISO
O_2 (1)
Air (2)
Air (1)
413
404
411
405
410
406
401
402
403
O_2
Air
Air
PicAdu0470

Figure 20 A-WGU-01, -02, -03, gas cylinder option O_2 + Air + Air (ISO version)

Tubing / Pipe data

No.	Type	Length (mm)	Routed from	Routed to
401	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
402	72271	pipe	Air-Yoke (2)	Air-Yoke pressure gauge
403	72271	pipe	Air-Yoke (1)	Air-Yoke pressure gauge
404	733472	350	Air-Yoke (1)	Non-return valve
405	733472	260	Air-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + Air + Air (ANSI version)

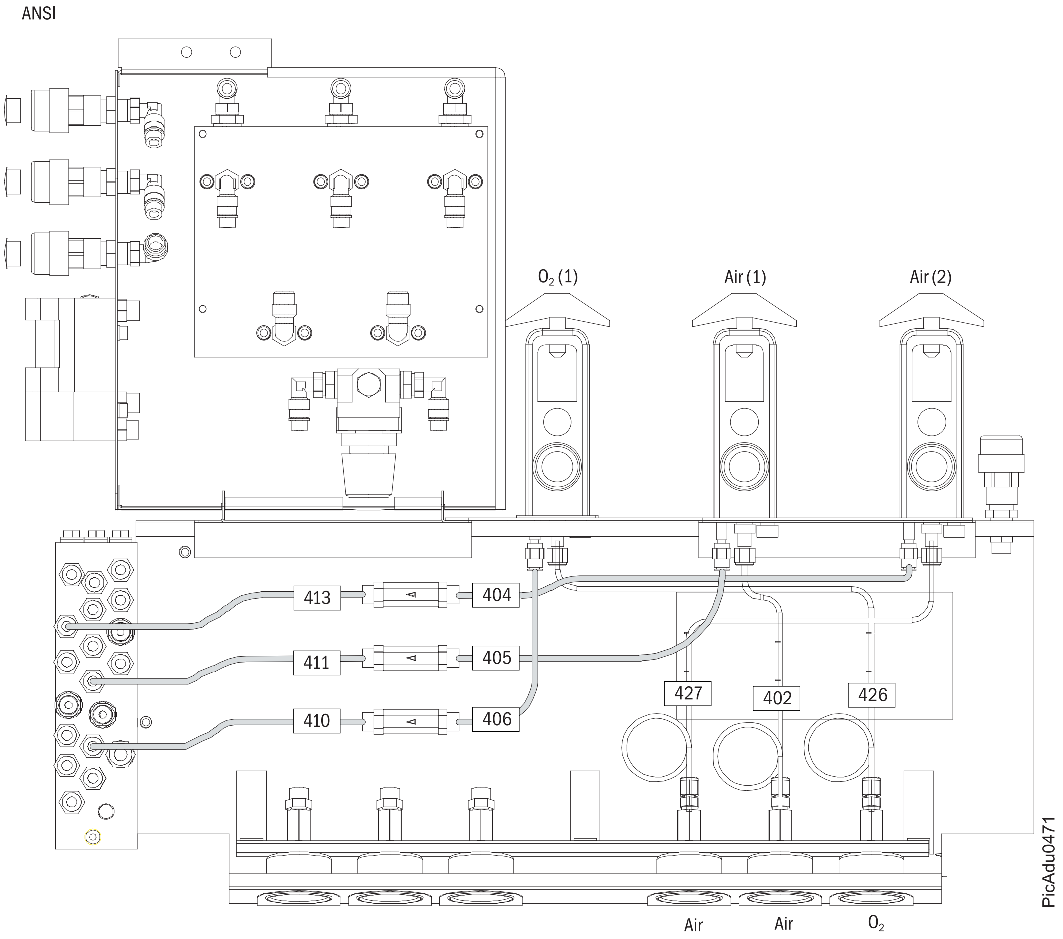

ANSI
O_2 (1)
Air (1)
Air (2)
413
404
411
405
410
406
427
402
426
Air
Air
O_2
PicAdu0471

Figure 21 A-WGU-01, -02, -03 gas cylinder option O_2 + Air + Air (ANSI version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
402	72271	pipe	Air-Yoke (2)	Air-Yoke pressure gauge
426	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
427	72271	pipe	Air-Yoke (1)	Air-Yoke pressure gauge
404	733472	350	Air-Yoke (1)	Non-return valve
405	733472	260	Air-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + Air + N_2O (ISO version)

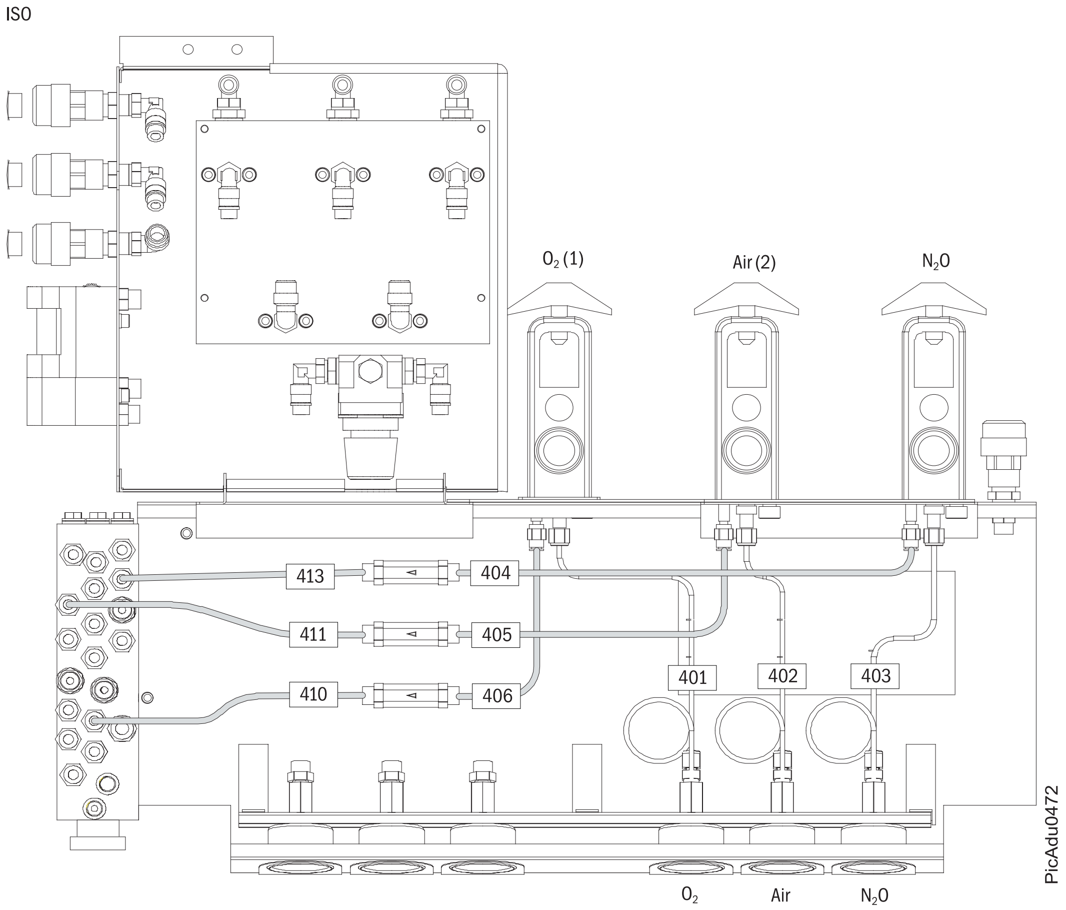

ISO
O_2 (1)
Air (2)
N_2O
413
404
411
405
410
406
401
402
403
O_2
Air
N_2O
PicAdu0472

Figure 22 A-WGU-01, -02, -03 gas cylinder option O_2 + Air + N_2O (ISO version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
401	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
402	72271	pipe	Air-Yoke (2)	Air-Yoke pressure gauge
403	72271	pipe	N_2O-Yoke	N_2O-Yoke pressure gauge
404	733472	350	N_2O-Yoke	Non-return valve
405	733472	260	Air-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

A-WGU-01, -02, -03 gas cylinder option O_2 + Air + N_2O (ANSI version)

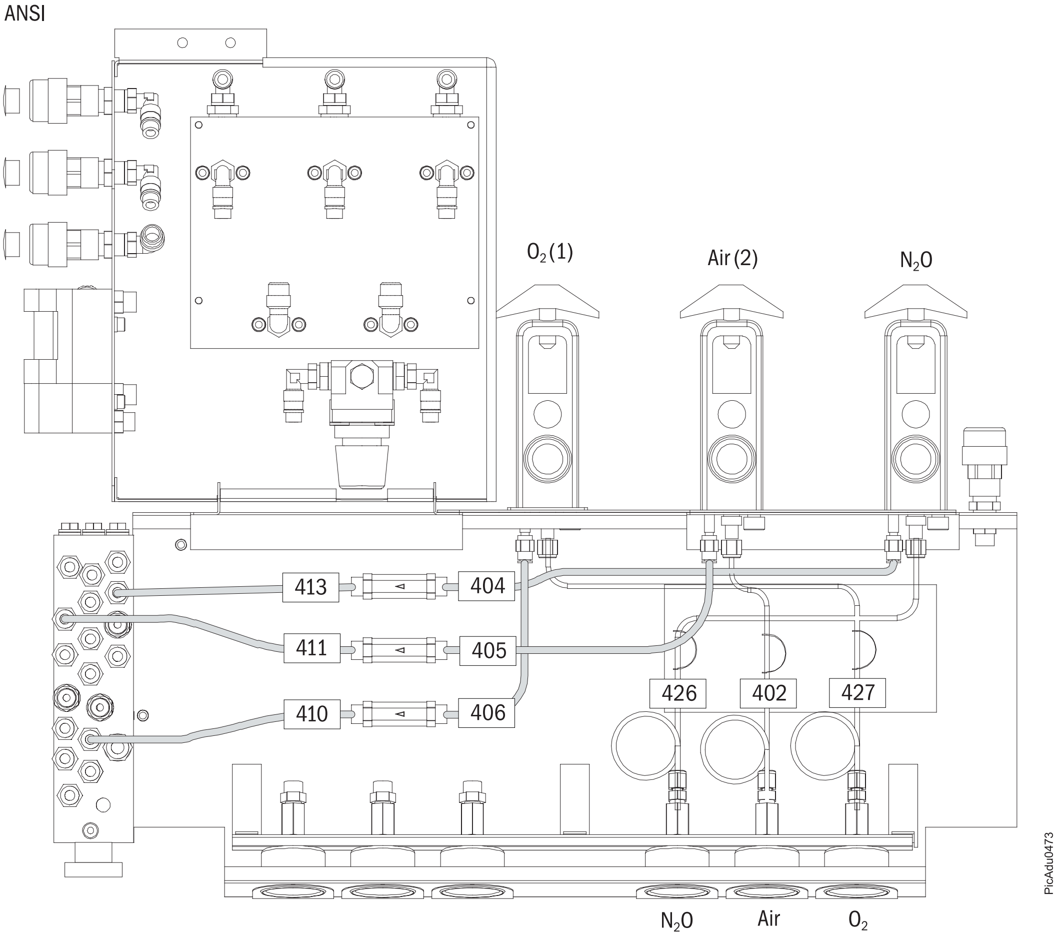

ANSI
O_2 (1)
Air (2)
N_2O
413
404
411
405
410
406
426
402
427
N_2O
Air
O_2
PicAdu0473

Figure 23 A-WGU-01, -02, -03 gas cylinder option O_2 + Air + N_2O (ANSI version)

Tubing / Pipe data				
No.	**Type**	**Length (mm)**	**Routed from**	**Routed to**
402	72271	pipe	Air-Yoke (2)	Air-Yoke pressure gauge
426	72271	pipe	O_2-Yoke (1)	O_2-Yoke pressure gauge
427	72271	pipe	N_2O-Yoke	N_2O-Yoke pressure gauge
404	733472	350	N_2O-Yoke	Non-return valve
405	733472	260	Air-Yoke (2)	Non-return valve
406	733472	220	O_2-Yoke (1)	Non-return valve
410	733472	130	Non-return valve	Connection block
411	733472	160	Non-return valve	Connection block
413	733472	180	Non-return valve	Connection block

Frame tubing interfaces between modules. No A-FGFI - oxygen flush mounted to A-WGU

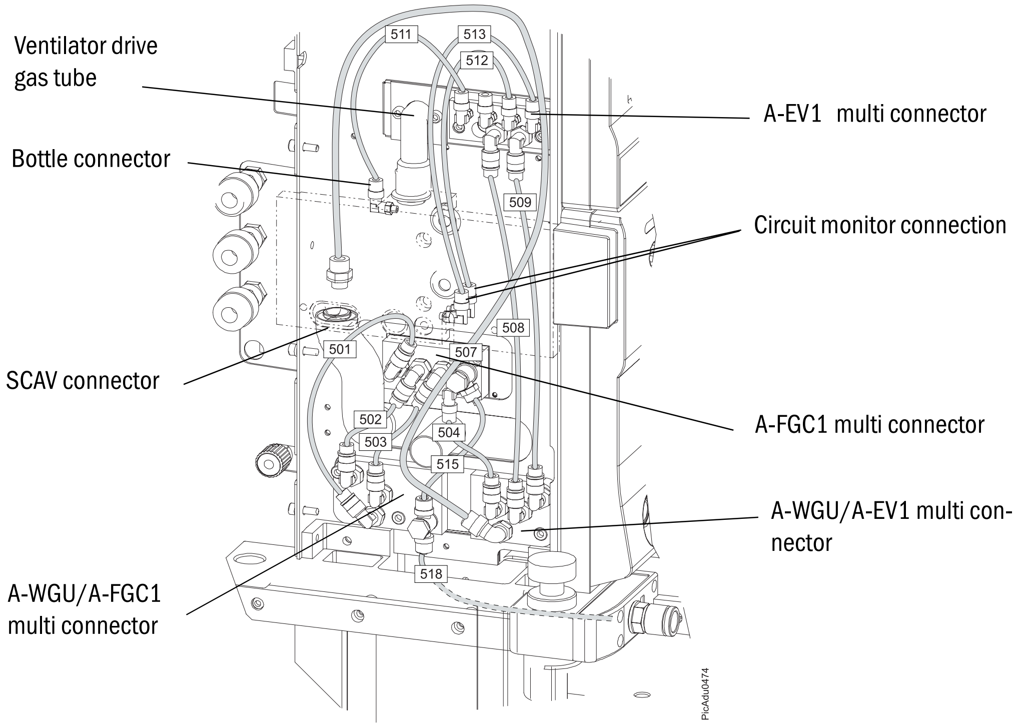

Ventilator drive gas tube
Bottle connector
SCAV connector
A-WGU/A-FGC1 multi connector
A-EV1 multi connector
Circuit monitor connection
A-FGC1 multi connector
A-WGU/A-EV1 multi connector
511
513
512
509
508
507
501
502
503
504
515
518
PicAdu0474

Figure 24 Frame tubing interfaces between modules, No A-FGFI - oxygen flush mounted to A-WGU

Tubing / Pipe data					
Tube No.	**Tube type**	**GAS**	**Length (mm)**	**From**	**To**
501	733472	N_2O	270	A-FGC1 Connector	WGU/A-FGC1 Connector
502	733472	Air	95	A-FGC1 Connector	WGU/A-FGC1 Connector
503	733472	O_2	102	A-FGC1 Connector	WGU/A-FGC1 Connector
504	733480	SCAV	85	A-FGC1 Connector	WGU/A-FGC1 Connector
*515	733476	FRESH	100	A-FGC1 Connector	WGU/A-FGC1 Connector
*518	733476	FRESH	165	WGU Connector	Fresh gas outlet
507	733479	SCAV	785	SCAV A-BB connection	A-WGU Connector
508	733472	O_2	290	A-EV1 connector	WGU/A-EV1 Connector
509	733472	Air	270	A-EV1 connector	WGU/A-EV1 Connector
511	733480	Bottle P.	280	A-EV1 connector	A-BB Bottle Connection

512	733480	Monitor.P	360	A-EV1 connector	A-BB Circuit Connection
513	733480	Circle P.	360	A-EV1 connector	A-BB Circuit Connection

***) On A-WGU-00 is tube 518 (∅8mm) labeled 506 (∅6mm) and tube 515 (∅8mm) labeled 505 (∅6mm).**

Frame tubing interfaces between modules. With A-FGFI - oxygen flush mounted to A-WGU.

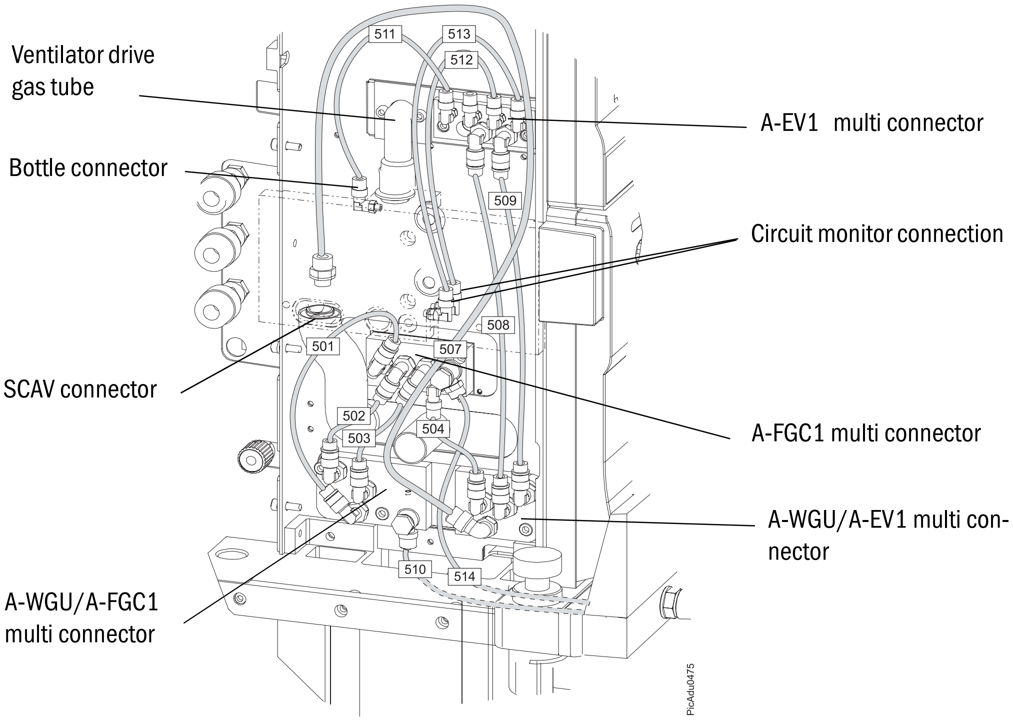

Ventilator drive gas tube
Bottle connector
SCAV connector
A-WGU/A-FGC1 multi connector
A-EV1 multi connector
Circuit monitor connection
A-FGC1 multi connector
A-WGU/A-EV1 multi connector
511
513
512
509
508
501
507
502
503
504
510
514
PicAdu0475

Figure 25 **Frame tubing interfaces between modules with A-FGFI - oxygen flush mounted to A-WGU.**

Tubing / Pipe data					
Tube No.	**Tube type**	**GAS**	**Length (mm)**	**From**	**To**
501	733472	N_2O	270	A-FGC1 Connector	WGU/A-FGC1 Connector
502	733472	Air	95	A-FGC1 Connector	WGU/A-FGC1 Connector
503	733472	O_2	102	A-FGC1 Connector	WGU/A-FGC1 Connector
504	733480	SCAV	85	A-FGC1 Connector	WGU/A-FGC1 Connector
514	733476	FRESH	230	A-FGC1 Connector	A-FGFI
510	733476	FRESH	165	WGU Connector	A-FGFI
507	733479	SCAV	785	SCAV A-BB connection	A-WGU Connector
508	733472	O_2	290	A-EV1 connector	WGU/A-EV1 Connector
509	733472	Air	270	A-EV1 connector	WGU/A-EV1 Connector
511	733480	Bottle P.	280	A-EV1 connector	A-BB Bottle Connection
512	733480	Monitor. P	360	A-EV1 connector	A-BB Circuit Connection
513	733480	Circle P.	360	A-EV1 connector	A-BB Circuit Connection

Frame tubing interfaces between modules. No A-FGFI - oxygen flush mounted to table

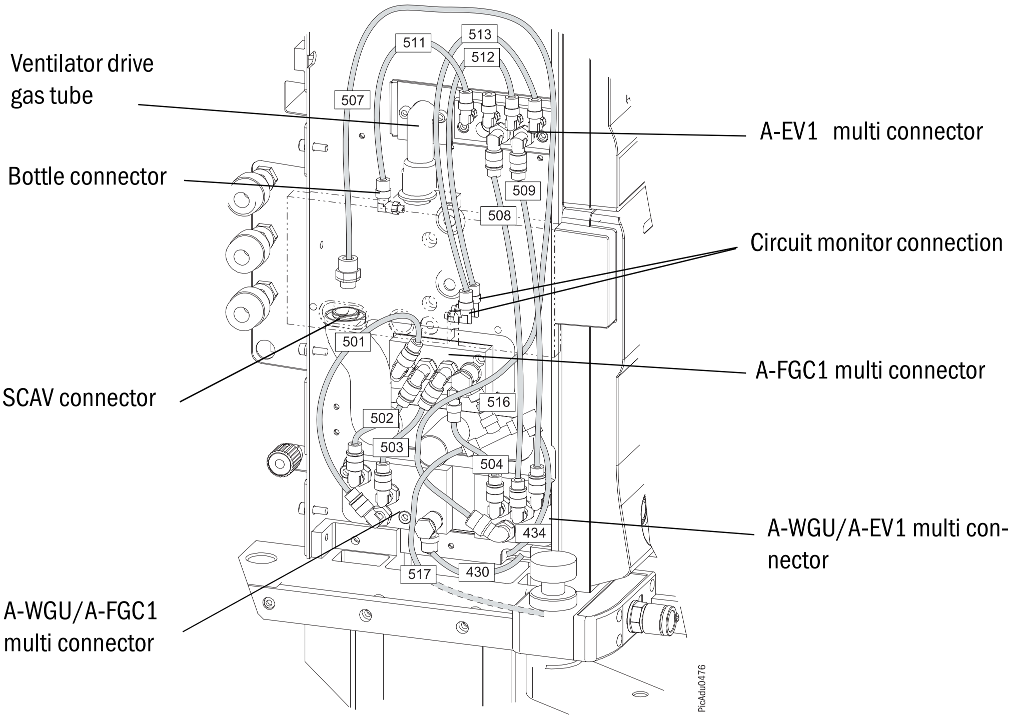

Ventilator drive gas tube
Bottle connector
SCAV connector
A-WGU/A-FGC1 multi connector
A-EV1 multi connector
Circuit monitor connection
A-FGC1 multi connector
A-WGU/A-EV1 multi connector
511
513
512
507
509
508
501
516
502
503
504
434
517
430
PicAdu0476

Figure 26 Frame tubing interfaces between modules no A-FGFI - oxygen flush mounted to table

Tubing / Pipe data					
Tube No.	**Tube type**	**GAS**	**Length (mm)**	**From**	**To**
430	733480	O_2	480	WGU Connector	O_2 Flush (**IN**)
501	733472	N_2O	270	A-FGC1 Connector	WGU/A-FGC1 Connector
502	733472	Air	95	A-FGC1 Connector	WGU/A-FGC1 Connector
503	733472	O_2	102	A-FGC1 Connector	WGU/A-FGC1 Connector
504	733480	SCAV	85	A-FGC1 Connector	WGU/A-FGC1 Connector
434	733480	O_2	570	O_2 Flush (**OUT**)	T-Connector
516	733476	FRESH	40	T-Connector	T-Connector
517	733476	FRESH	220	WGU Connector	Fresh gas outlet
507	733479	SCAV	785	SCAV A-BB connection	A-WGU Connector
508	733472	O_2	290	A-EV1 connector	WGU/A-EV1 Connector
509	733472	Air	270	A-EV1 connector	WGU/A-EV1 Connector
511	733480	Bottle P.	280	A-EV1 connector	A-BB Bottle Connection
512	733480	Monitor.P	360	A-EV1 connector	A-BB Circuit Connection
513	733480	Circle P.	360	A-EV1 connector	A-BB Circuit Connection

Frame tubing interfaces between modules. With A-FGFI -oxygen flush mounted to table

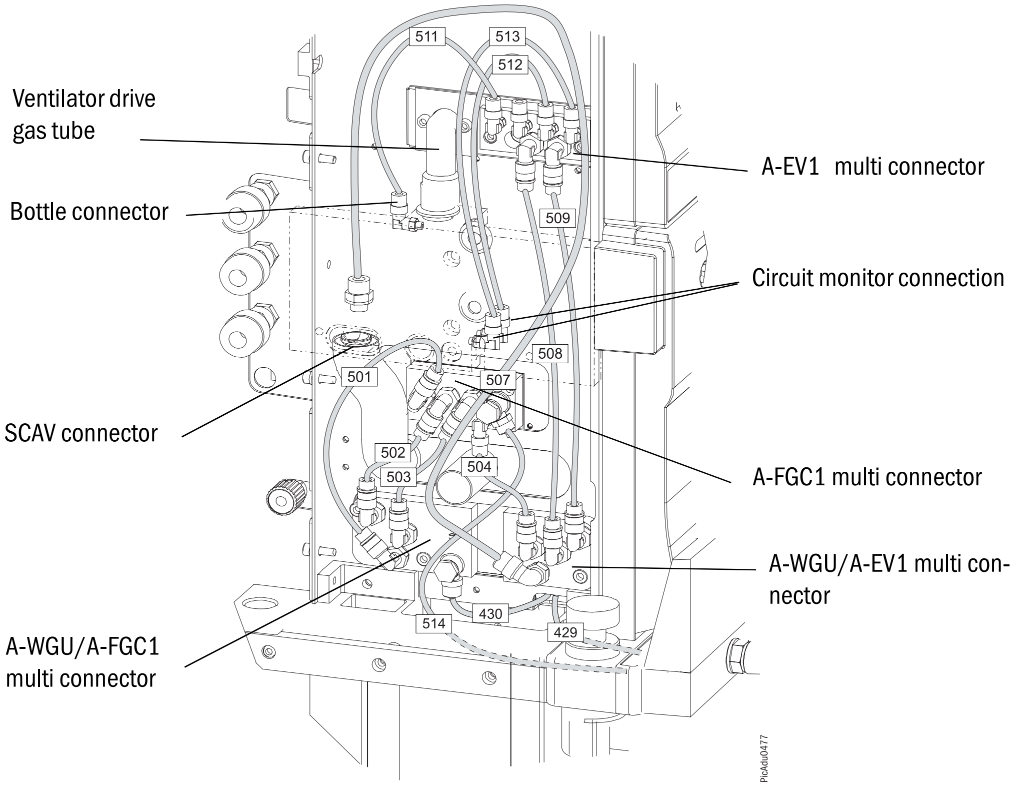

511
513
512
Ventilator drive gas tube
A-EV1 multi connector
Bottle connector
509
Circuit monitor connection
508
501
507
SCAV connector
502
503
504
A-FGC1 multi connector
A-WGU/A-EV1 multi connector
430
514
429
A-WGU/A-FGC1 multi connector
PicAdu0477

Figure 27 **Frame tubing interfaces between modules with A-FGFI - oxygen flush mounted to table**

Tubing / Pipe data					
Tube No.	**Tube type**	**GAS**	**Length (mm)**	**From**	**To**
430	733480	O_2	480	WGU Connector	O_2 Flush (**IN**)
501	733472	N_2O	270	A-FGC1 Connector	WGU/A-FGC1 Connector
502	733472	Air	95	A-FGC1 Connector	WGU/A-FGC1 Connector
503	733472	O_2	102	A-FGC1 Connector	WGU/A-FGC1 Connector
504	733480	SCAV	85	A-FGC1 Connector	WGU/A-FGC1 Connector
429	733480	O_2	520	O_2 Flush (**OUT**)	A-FGFI
514	733476	FRESH	230	A-FGC1 Connector	A-FGFI
507	733479	SCAV	785	SCAV A-BB connection	A-WGU Connector
508	733472	O_2	290	A-EV1 connector	WGU/A-EV1 Connector
509	733472	Air	270	A-EV1 connector	WGU/A-EV1 Connector
511	733480	Bottle P.	280	A-EV1 connector	A-BB Bottle Connection
512	733480	Monitor.P	360	A-EV1 connector	A-BB Circuit Connection
513	733480	Circle P.	360	A-EV1 connector	A-BB Circuit Connection

Reservoir tube location

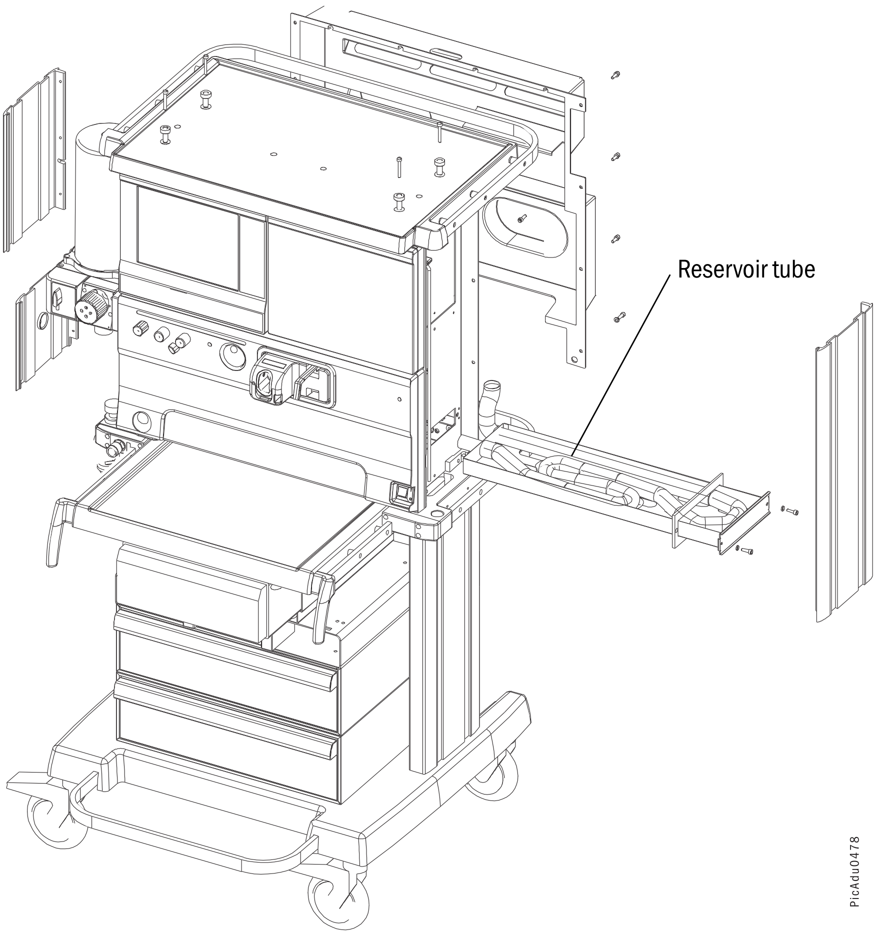


Figure 28 **Reservoir tube location**

Double fresh gas outlet, A-DFG1

NOTE: This option is available for France, Italy and Belgium only.

There is a mechanically controlled valve that is connected directly to the fresh gas outlet. Two separate breathing systems can be connected to the two outlets of the valve.

The operator manually selects which outlet (breathing system) is in use with the fresh gas flow.

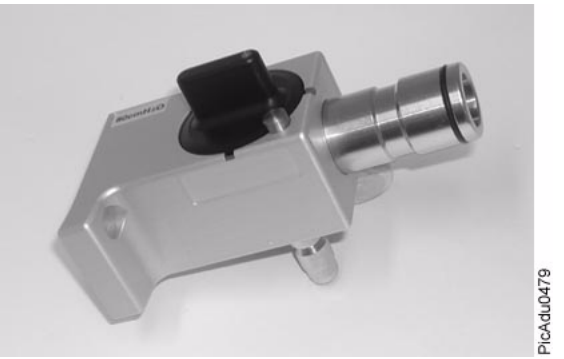


Figure 29 **Double fresh gas outlet**

Fresh gas flow 1 indicator, A-FGFI (Option)

With this option the fresh gas flow rate will be indicated.

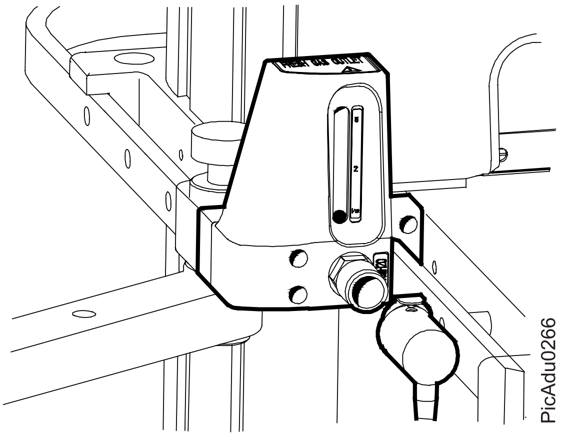

FRESH GAS OUTLET
5
2
l/m
PicAdu0266

Figure 30 Fresh gas flow 1 indicator, A-FGFI

REPAIR INSTRUCTIONS A-AUF

General

To service the WGU and its internal parts it must be removed from the frame.

For replacing a tube, connectors and other parts should appropriate pneumatic drawing or exploded view in this chapter be used.

Specific options and spare parts that need special attention during installation will contain a separate installation instruction with the part.

When the gas inlet assembly is folded up after servicing the A-WGU make sure according to picture below that no tubings get chinked.

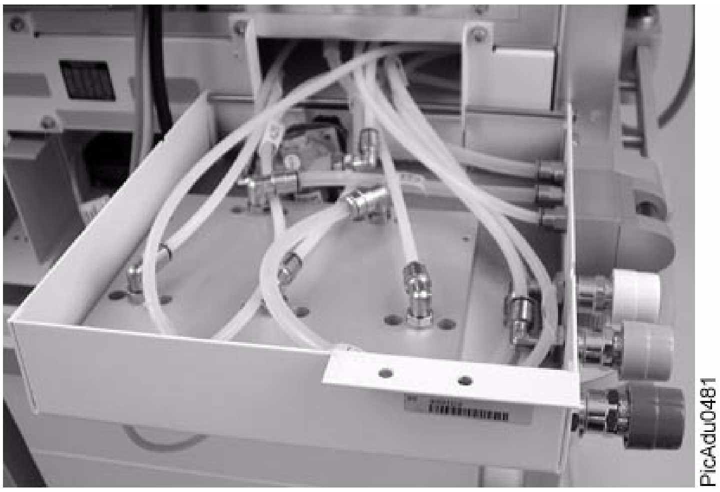


Figure 31 Folding up the gas inlet assembly

After servicing of the Fresh gas outlet or the Fresh Gas Flow Indicator make sure according to picture below that tubings behind the left lower side panel not have get chinked.

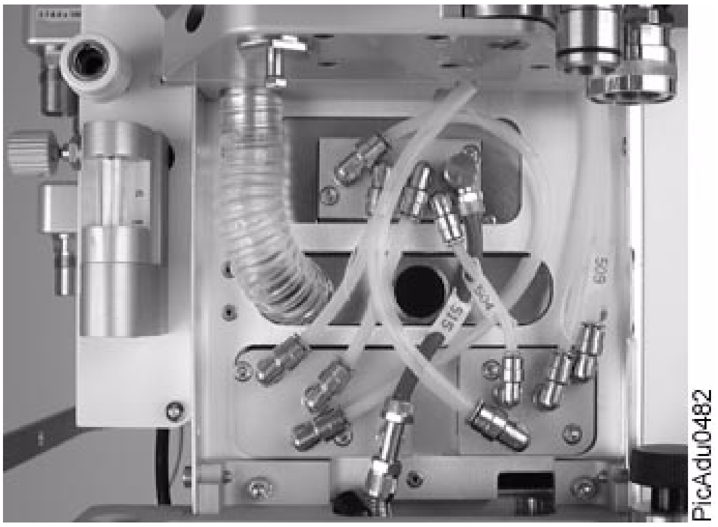


Figure 32 Tubings behind the left lower side

Removal of the WGU

Follow the steps below to remove the WGU.
Tools: 4 mm Allen wrench

1. Disconnect the pipeline gases and close cylinder valves.
2. Disconnect all external gas connections and reserve gas cylinders from the WGU.
3. Turn the N_2O/Air selector switch into N_2O position and release N_2O and Air pressures by first opening the N_2O flow fully and then opening O_2 flow to 1 l/min.
4. Turn the N_2O/Air selector switch to Air position and release Air pressure by opening the Air flow control.
5. Remove the rear plastic cover (10 screws).
6. Remove the lower left side cover underneath the bellows block (? Allen screws).

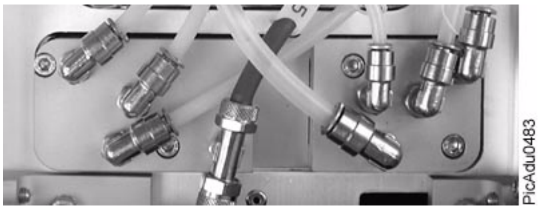


Figure 33 Two multiconnectors mounted with four screws

7. Remove the 10 remaining screws (plus washers) which hold the WGU to the frame.
8. Gently pull out the WGU and put it on a bench.
9. To reinstall after servicing, do the above steps in reversed order. Make sure the multiconnector gaskets are in place before mounting them back the A-WGU.
10. Do a Functional Check. Replacement of Non-return Valves in the WGU

Replacing tubings or connectors

Always replace tubing that are damaged in anyway.

Always use D-O supplied tubing so correct type of material is maintained at its application.

Inspect the end of tubing before installing it to a connector, if the tube end are damage in any way can it be cut straight with a racer sharp tool before connected. If the tube get to short so it gets tensed at installation must it be replaced with a new tube.

When removing a tube from a quick connector the locking mechanism must first be pushed towards the connector before the tube can be pulled out. See figure below.

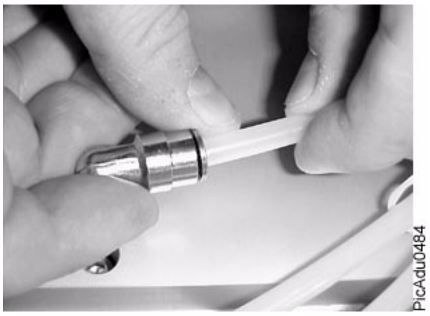


Figure 34 Removing a tube from a quick connector

To install a tube to a quick connector, push the tube firmly into the bottom of the connector. Then it will be locked (see figure below).

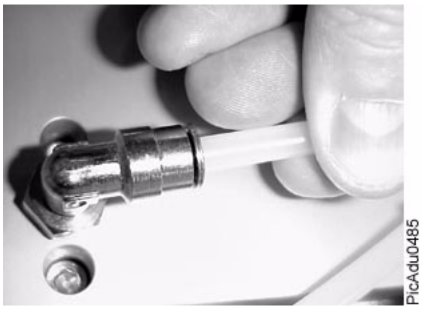

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Figure 35 **Push the tube firmly to the bottom of the connector**

Some threads on joints and connectors in the A-WGU are secured with Loctite, There are two types of Loctite that are used: Red 542 and Green 270. Refer to pictures below for correct application.

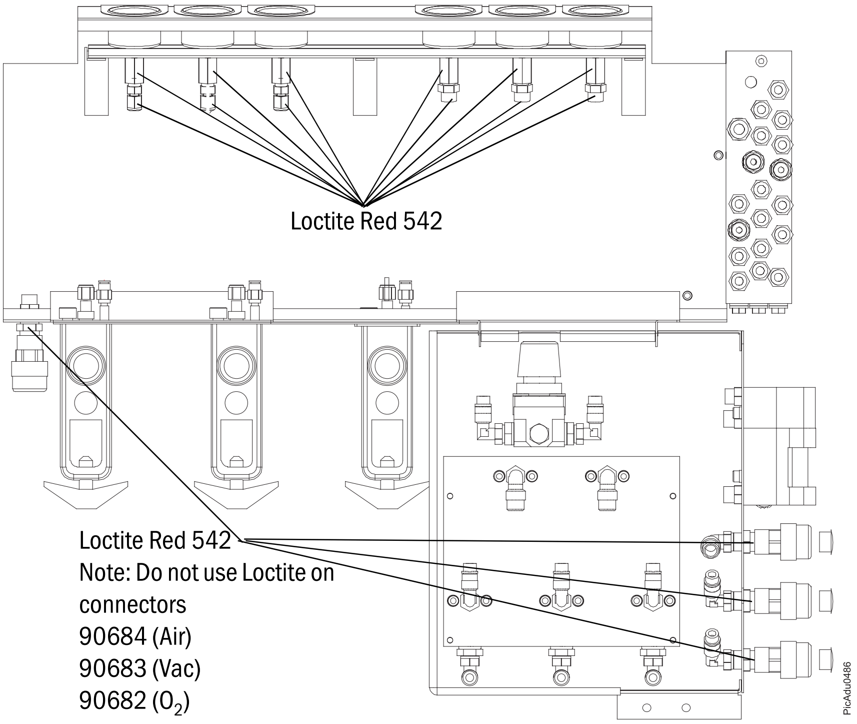
Loctite Red 542
Loctite Red 542
Note: Do not use Loctite on connectors
90684 (Air)
90683 (Vac)
90682 (O_2)
PicAdu0486

Figure 36 **Applying Loctite to joints and connectors**

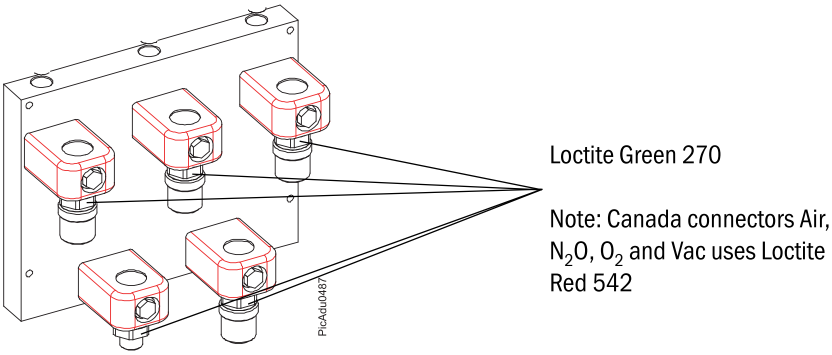
Loctite Green 270
Note: Canada connectors Air, N_2O, O_2 and Vac uses Loctite Red 542
PicAdu0487

Figure 37 **Applying Loctite to gas inlet connectors**

Replacement of non-return valves in the A-WGU

Tools needed: *Wrench 17 mm*

Allen wrench 4 mm

1. Depressurize the system from gas.
2. Remove the rear cover of the ADU
3. Remove the 4 Allen screws that fix the gas inlet assembly to the frame of the WGU.
4. Remove the 2 Allen screws that secure the gas inlet assembly to the frame and fold it down.

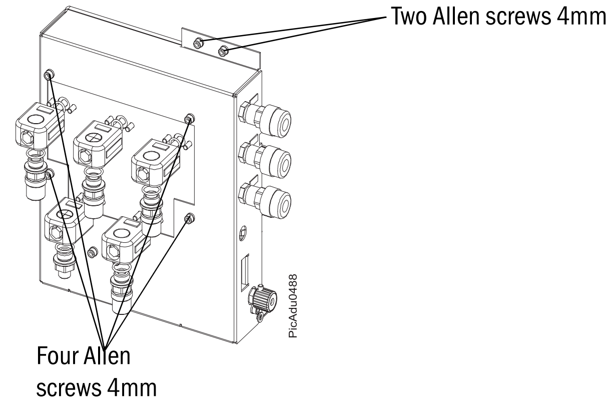

Figure 38 Replacement of non-return valves, Allen screws.

5. Disconnect the tubing routed to the nipple(s) (1) on the picture below.
6. Unscrew nipple (2) with a wrench.
7. Replace the non-return valve(s) (4).
8. Replace seal (3) if worn.
9. Do the above steps in reversed order after service.

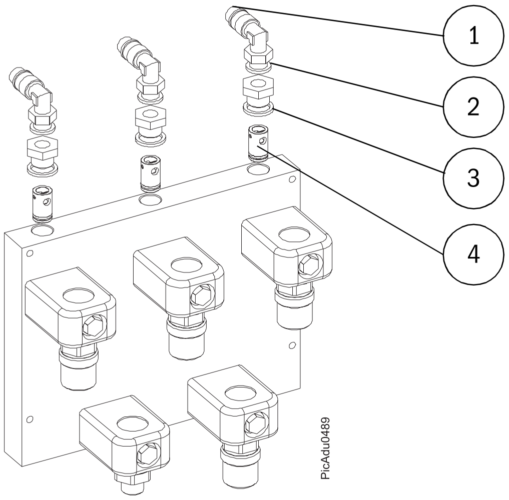

Figure 39 Replacement of non-return valves

Installation of double fresh gas outlet, A-DFG1 (Option)

To install or replacing the Double Fresh Gas outlet valve proceed as follow:

1. Remove old screw, (1) below.
2. Attach the A-DFG1 and use new, long screws (2).
3. Check function of the safety valve.
4. Perform a System Check.

NOTE: This outlet is available for France, Italy and Belgium only.

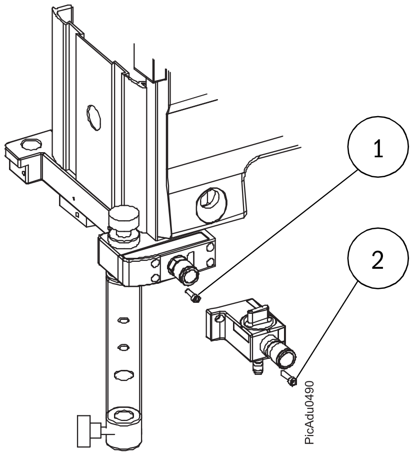

Figure 40 Installation of double fresh gas outlet, A-DFG1

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CALIBRATION A-AUF

General

The required tools and settings for each calibration procedure are stated below each heading.

Oxygen flush adjustment

Tools: *4 mm Allen wrench*
Flow and pressure test device

Settings *ADU off*

O_2 pipeline pressure connected to A-WGU
Fresh gas flows closed

1. Remove rear plastic cover (8 Allen screws)
2. Remove the two uppers Allen screws (1) as seen below and fold down the gas inlet assembly block (2).

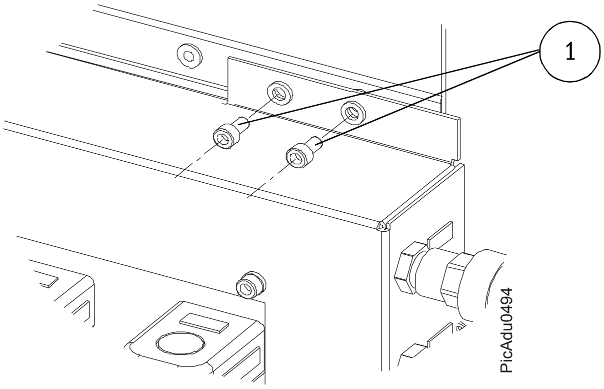

Figure 41 Removing screws from the gas inlet assembly box

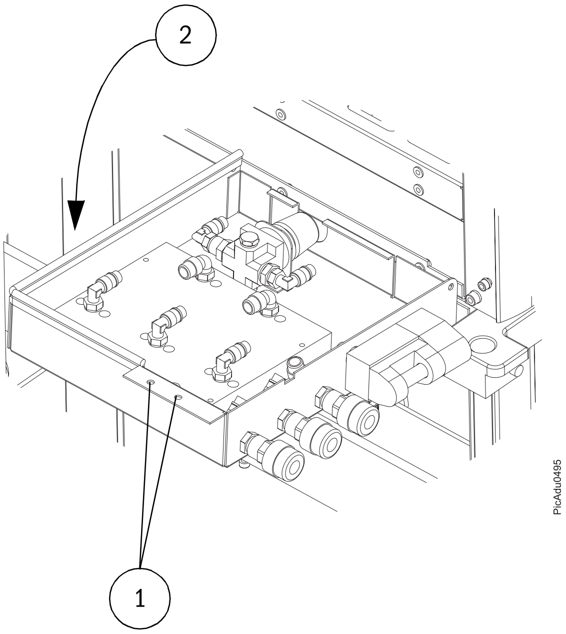

Figure 42 Folding down the gas inlet assembly box

3. Select high O_2 flow range on the test device and zero it.
4. Connect the test device ”high flow” inlet to the fresh gas outlet using a leak free patient circuit hose.

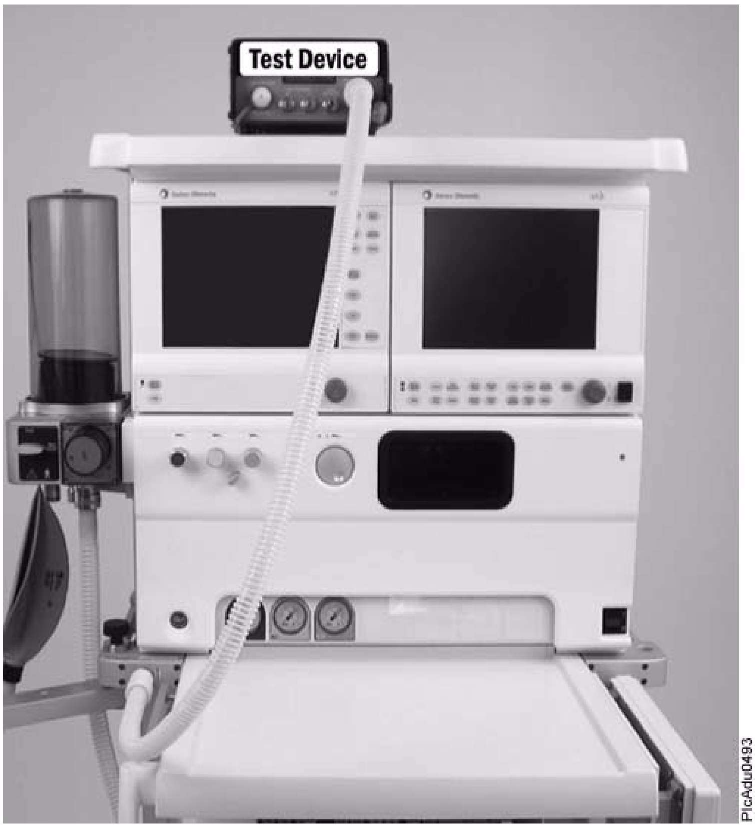

Figure 43 Oxygen flush adjustment setup

5. Check that the ADU O_2 pressure gauge shows at least 270 kPa (39.16 PSI) even when the O_2 flush control is pushed.

Figure 44

6. Push the ”O_2 flush” and check that the test device indicates:
   25-35 l/min. for A-WGU-00,
   35-50 l/min. for A-WGU-01,-02 and -03.
   If not; lock-up the regulator (3) and adjust it. (see picture below)

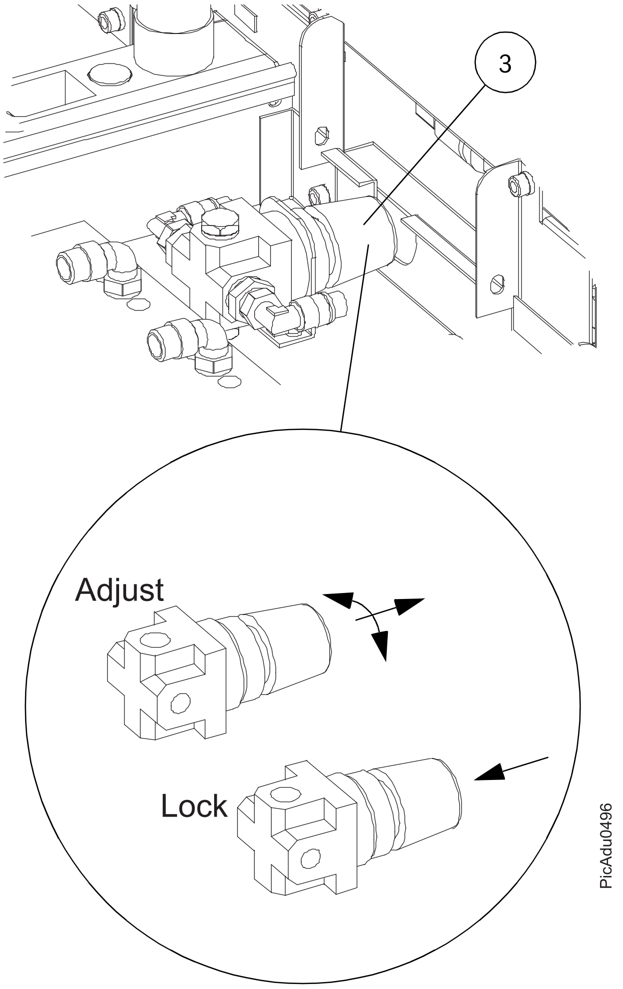

Figure 45 **Adjustment of regulator**

7. After adjustment: lock the regulator.
8. Fold up the gas inlet assembly block into place with the two screws.
   Make sure that no tubing get chinked.
9. Refit the rear cover.

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TROUBLESHOOTING A-AUF

Guidelines for troubleshooting leakage in the A-WGU

Big leaks are normally easy to find since you can hear from them. Small leaks are more difficult to trace and they are discovered during the Functional checks routine.

Use the guidelines below to find where leaks are located.

There are some tools that will help to find the leak

- Leak finding spray or soap water
- High pressure test adapter P/N: 8500002
- Test device for measuring pressures.
- Extra multiconnectors that can be plugged (see spare part list s for connectors and plugs)

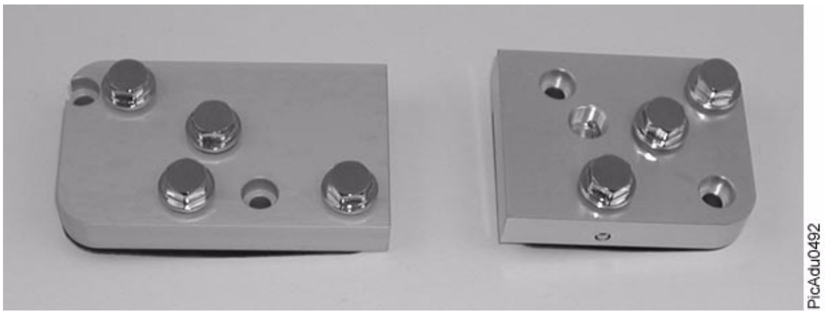

Figure 46

Extra multi-connectors

	Actions	Comments
1	Check that the test equipment and its connection do not leak.	Correct leak
2	Perform the high pressure leak test and the WGU non-return valve tests according to the Functional Check. Remove Yoke cylinders if attached to the A-WGU, Note that the gas inlet assembly must be folded up when non- return valves are tested.	If the high pressure leak test pass, but not the non-return valve leak test. Is the problem may be a leaking non- return valve in the A-WGU.
3	If the high pressure test fails	Check that all multiconnectors are correctly mounted and have a good gasket.
4	Find out what gas is leaking.	Use High pressure test adapter to test separate each gas line. Use also the diagnostic pages. **If Air leaks** - Check that scavenging ejector is closed. - Check for leak in Air Auxiliary outlets on the A-WGU. **If O_2 leak**s Check for leak in O_2 Auxiliary outlets on the A-WGU,

	Actions	**Comments**
5	Remove extra Cylinders from the yoke(s) and check if any gas is escaping out from the yoke.	If the ADU is equipped with Yokes will there be non-return valves in the A-WGU to prevent pipeline gas to escape to the ATM if not cylinder is attached to the Yoke. If gas escaping out, is this an indication that one-way valve have a leak.
6	If the leak is traced to some internally part in the A-WGU the Wall Gas Unit must be removed from the ADU Frame. Install plugged multiconnectors to the A-WGU and pressurize the A-WGU.	- Check that all internal tubings are correctly mounted. - Move tubing gently and try hear where it leaks. - Use leak spray to locate the leak. (make sure to clean afterwards)

SPARE PARTS A-AUF

General

*= Parts compatible with the AS/3 ADU, S/N: 293001-294000, 981001-981110

Cart A-CART and frame A-AUF

Item	Item description	Order No.
1	Aladin slots	A-AS1
2	Gauge window for WGU	893165
3	Front Panel with hole for O_2flush, including On/Standby switch (cover both ISO and ANSI).	8501903
-	Front panel without hole for O_2 flush, including On/Standby switch (cover both ISO and ANSI)	8501836
4	Large table (without Oxygen flush hole in table)	8502861
-	Large table (with Oxygen flush hole in table)	8502860
5	Right handle	8501773
6	Foot Rail cart	8501642
7	Drawers (1 piece)	A-DR
8	Blind plate monitor, LCD Display	8501830
9	Top shelf without rails	8501748
10	Dove Tail Side Cover kit (the Kit Includes all 3 side covers).	8504128
11	Reservoir tube	8500074
-	Left handle	8501774
12	Monitor tap (for top shelf)	8500718
13	Module frame rack A-MFR1 (can only be installed in units with large table 8502860 or 8502861	A-MFR1

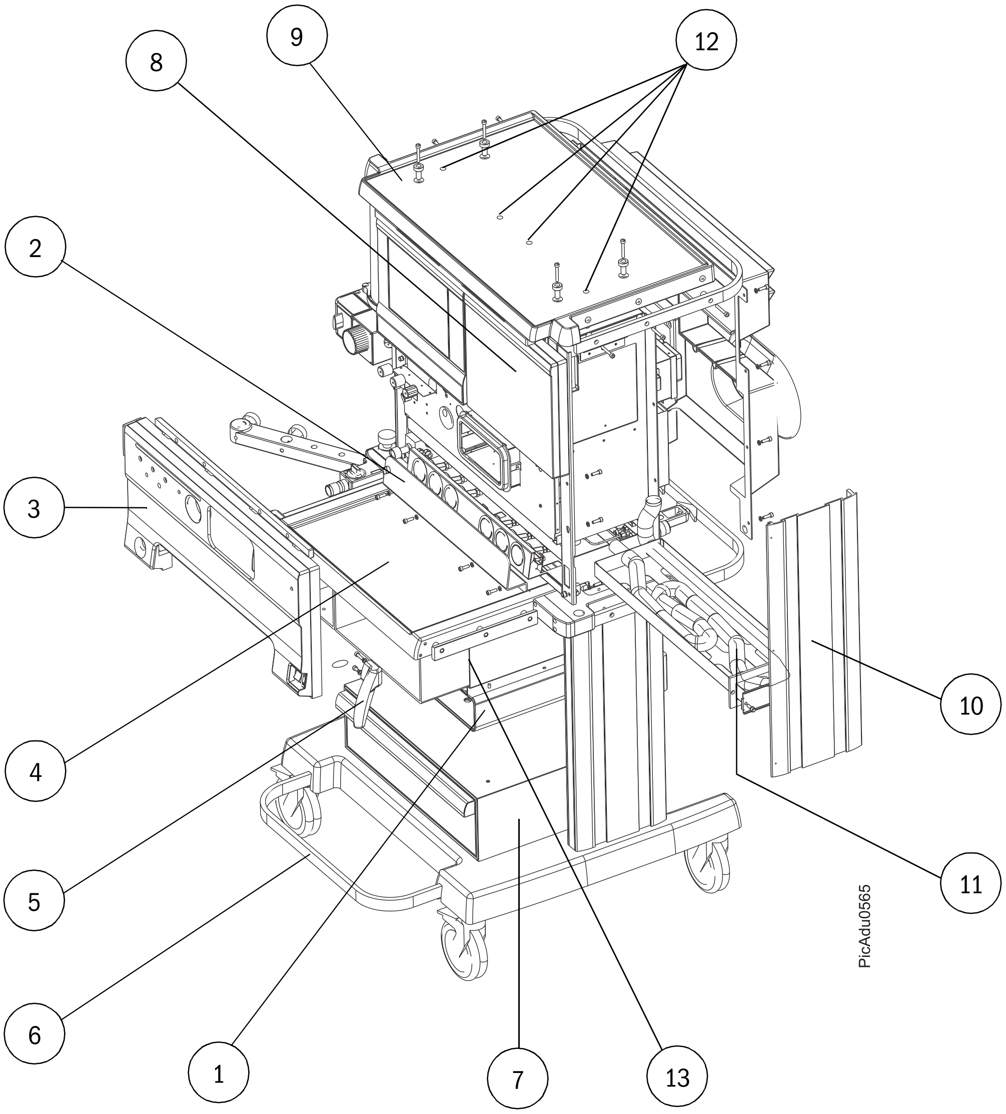
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Figure 47 Exploded view of cart (A-CART) and frame (A-AUF)

Item	Item description	Order No.
-	Extra table mounted to right side	A-OT
1	Accessory rail top shelf with straight edges 25x10 mm (DIN type)	8501638
1	Accessory rail top shelf with sloping edge 25/30x10 mm	8501639
2	Back Cover	8501704

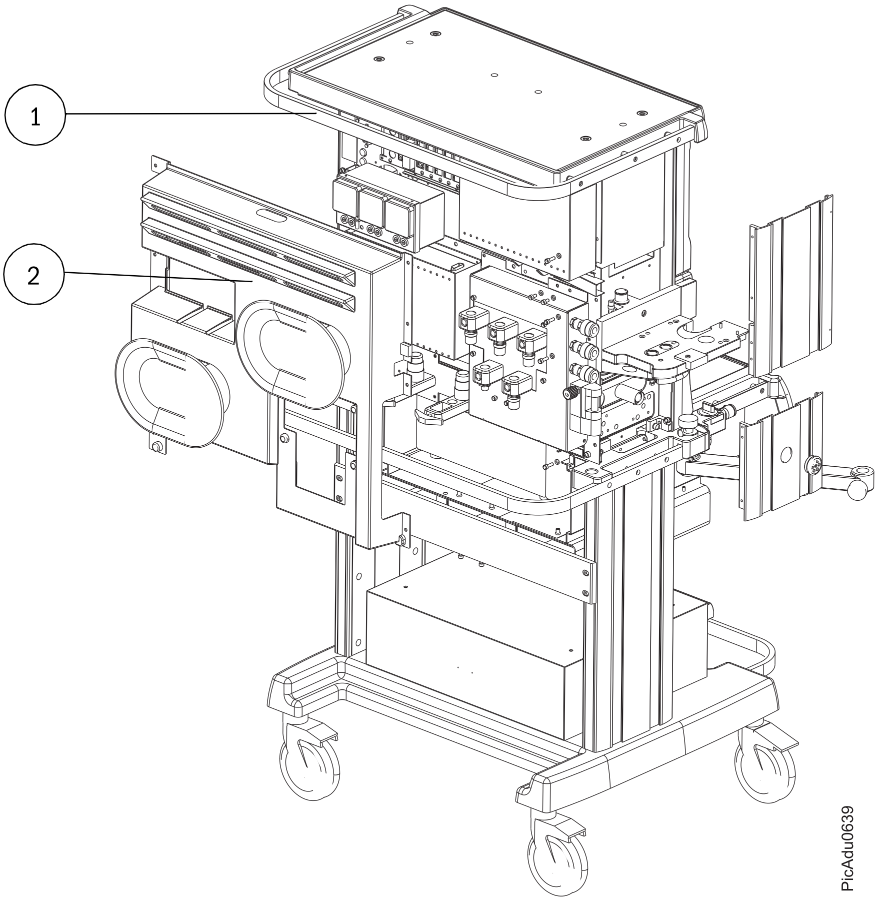

Figure 48 **Rear side of ADU**

Item	Item description	Order No.
1	A-CART C Dove Tail legs profile kit (includes both the left and right side legs of the cart).	8504125
1	A-CART Dove Tail legs profile kit (includes both the left and right side legs of the cart).	8504126
1	A-CART H Dove Tail legs profile kit (includes both the left and right side legs of the cart).	8504127
2	Rear wheel (1 piece)	90688*
2	Rear double wheel without brakes (1 piece)	68902
3	Front wheel with brakes (1 piece)	90689*
3	Front double wheel with brakes (1 piece)	68901
-	Mini wheels for sealing mounted ADU (4 pieces)	906890

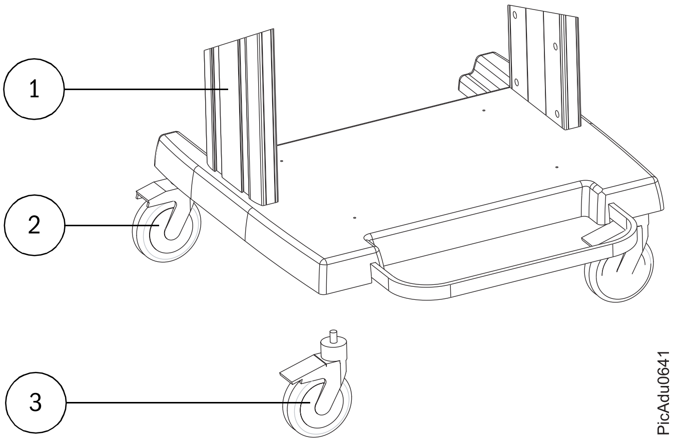

Figure 49

Front panel agent sticker

Item description	Order No.
Front panel Agent sticker (English/US/French)	8501780
Front panel Agent sticker (German)	8501781
Front panel Agent sticker (Dutch)	8501782
Front panel Agent sticker (Swedish)	8501783
Front panel Agent sticker (Italian/Spanish)	8501793
Front panel Agent sticker (Norwegian)	8501794
Front panel Agent sticker (Finnish)	8501795
Front panel Agent sticker (Danish)	8501796

Spare parts for the Wall Gas Unit (excluding the gas inlet block)

Table YES (Y) = To replace the spare part the A-WGU should be removed from frame.

Table NO (N)= Spare part can be installed without removing the A-WGU from frame.

XX = Depending where installed.

Item	Item description	Order No.	Y	N
1	O_2 flush valve (only for units with WGU-01,-02,-03) Same item as when the flush is located at front table.	8501419	X	X
1	O_2 flush valve (only for units with WGU-00)	90700*	X	
-	O_2 Flush label blue	892891		X
-	O_2 Flush label green	892892		X
2	Pressure gauge 0-10 * 100 kPa for Wall gas inlets	51401	X	
3	Pressure gauge 0-315 * 100 kPa for O_2 cylinder and Air	51403	X	
3	Pressure gauge 0-100 * 100 kPa for N_2O cylinder	51402	X	
5	Overpressure valve (9 bar)	90706*	X	
6	Non-return valve, O_2, Air, N_2O (Gas cylinders)	585690*	X	
7	O_2 flush regulator	57116		X
8	Straight quick connector 8 mm	646770	X	
9	Straight quick connector 6 mm	64677	X	
10	Connection piece	883452	X	
11	Connector to yoke pressure gauge	64688	X	
12	N_2O yoke PIN type	90651	X	
12	N_2O yoke DIN type	90680	X	
12	O_2 yoke PIN type	90650	X	
12	O_2 yoke DIN type	90679	X	
12	Air yoke PIN type	906500	X	
13	Connector yoke (mounted on Yoke). Can not be ordered.	---------	X	
14	Straight quick connector yoke (includes seal)	646772	X	
15	Screw plug	63251	X	
16	Straight quick connector 8 mm VAC	646774	X	
17	Straight quick connector 6 mm	64677	X	
18	Rubber molding	734581		X
21	AUX quick connector, VAC AGA type (yellow hat)	90683	X	X
21	AUX quick connector, VAC (US)	90726	X	X
22	Nut to VAC and Air quick connector (DISS)	890048	X	X
23	AUX quick connector, Air (white/black hat)	90684	X	X
23	AUX quick connector, Air (US)	90725	X	X
23	AUX quick connector, Air (UK)	906845	X	X
24	AUX quick connector, O_2 (white hat)	90682		X
24	AUX quick connector, O_2 (US)	90724		X

Item	Item description	Order No.	Y	N
24	AUX quick connector, O_2 (UK)	906825		X
25	Nut to O_2 AUX quick connector	890049		X
26	Angled quick connector 6 mm	64678		X
27	A-SEJ2 Scavenging (Fits also A-WGU-00 if frame gas inlet P/N 8501750 is installed.)	A-SEJ2		X
28	Flow indicator without ejector	8500100		X

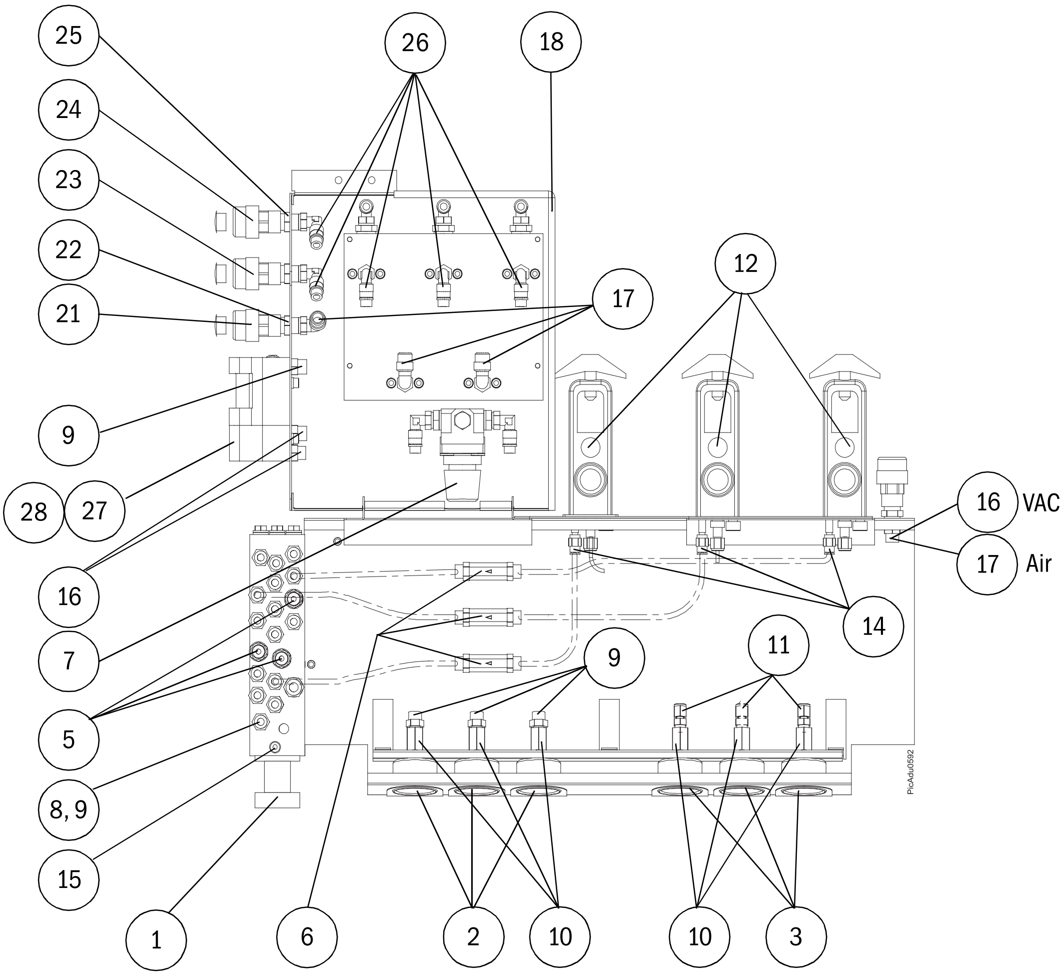
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Figure 50 The Wall Gas Unit (excluding the gas inlet box)

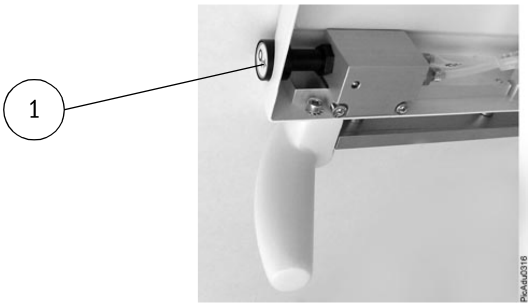
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Figure 51 O_2 flush mounted in front table (view from below)

Gas inlet block

Item	Item description	Order No.
1	Gas inlet block DKD France	8500206
1	Gas inlet block DISS Canada	8500207
1	Gas inlet block NIST	8500208
2	N_2O inlet gas connector DKD (France)	90710
2	N_2O inlet gas connector DISS	907507
2	N_2O inlet gas connector NIST	889686
2	N_2O inlet gas connector (US)	892882
3	Air inlet gas connector DKD (France)	90709
3	Air inlet gas connector DISS	907509
3	Air inlet gas connector NIST	889684
3	Air inlet gas connector (US)	892883
5	Gas filter plug	883440
4	Gas inlet filter	57142*
6	Gas filter gasket	64671*
7	EVAC inlet gas connector NIST	889729
7	EVAC inlet gas connector (Germany and Canada)	893396
7	EVAC inlet gas connector DISS/body	892884
7	EVAC Japan	8500256
7	EVAC connector (Choke Orifice for high vacuum systems) US (Including O-ring No.65386)	8501008
8	O-ring to inlet gas connectors	65386
9	VAC inlet gas connector DKD (France)	90708
9	VAC inlet gas connector DISS	907508
9	VAC inlet gas connector NIST	889727
9	VAC inlet gas connector DISS/body	892885
10	Frame for Gas inlet block	8501750
11	Angled quick connector 6mm	64678
12	Connecting piece	64679
13	Washer seal 1	64672
14	Non-return valve, O_2, Air, N_2O (Wall gas)	889679
15	O_2 inlet gas connector DKD (France)	90707
15	O_2 inlet gas connector DISS	907506
15	O_2 inlet gas connector NIST	889682
15	O_2 inlet gas connector (US)	892881

Item	Item description	Order No.
16	O-ring gas inlet block	656499

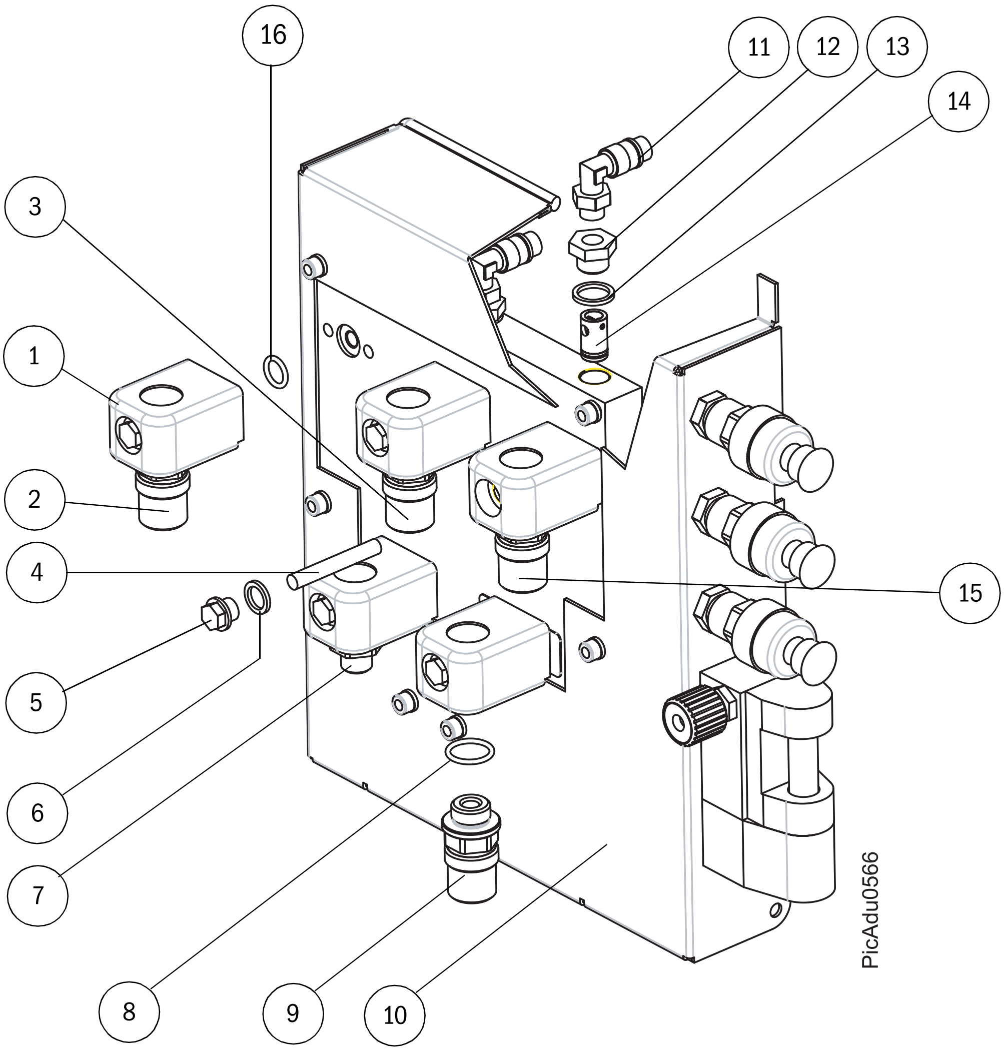
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Figure 52 Exploded view of the gas inlet box

Gas inlet block

Item	Item description	Order No.
1	Gas label white	884953
1	Gas label blue	884958
1	Gas label black/white	884959
1	Gas label brown/blue	884960
1	Gas label Yellow	884961
1	Gas label grey	884962
1	Gas label green	884963
1	Gas label brown	886281
1	Gas label red	887073
2	Label text: P Recom 2.7-8.0 x 100kPa	890470
2	Label text 2.7-8.0 x 100kPa	890471
3	Gas label yellow/red	889260
3	Gas label black	889884
3	Gas label O_2	892762
3	Gas label N_2O	892763
3	Gas label Air	892764
3	Gas label Luft	892765
3	Gas label Lucht	892766
3	Gas label Aire	892767
3	Gas label Aria	892768
3	Gas label Evac	892769
3	Gas label Vac	892770
3	Gas label Vide	892771
3	Gas label Vouto	892772
3	Gas label Ilma	894351
3	Gas label Vak.	8500214
3	Gas label Evak.	8500215
3	Gas label Vác	8500501
3	Gas label Ar	8500502
4	Gas label EVAC (Max. 50 l/min.)	8501493

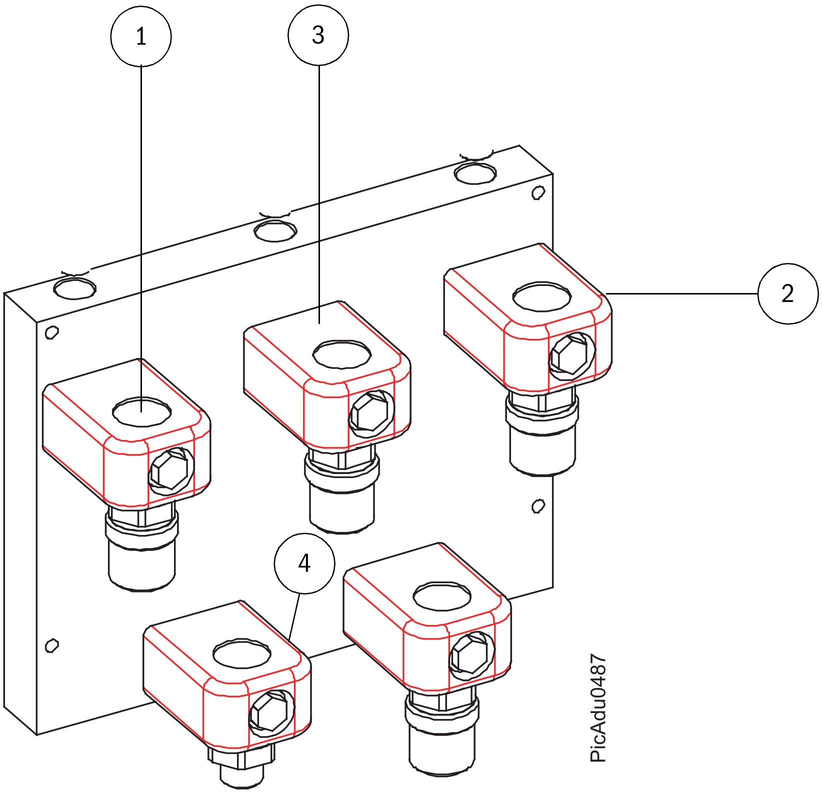
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Figure 53 Exploded view of the gas inlet block and the gas labels

Hose connectors A-WGU side

Item	Item description	Order No.
1	Hose connector N_2O NIST (A-WGU side)	90716
1	Hose connector N_2O DISS 1/4” Hex (A-WGU side)	907501
2	Hose connector EVAC (A-WGU side)	90714
2	Hose connector EVAC DISS 1/4” Hex (A-WGU side)	907504
2	Hose connector choke orifice	8501058
3	Hose connector Air NIST (A-WGU side)	90718
3	Hose connector Air DISS 1/4” Hex (A-WGU side)	907502
4	Hose connector O_2 NIST (A-WGU side)	90715
4	Hose connector O_2 DISS 1/4” Hex (A-WGU side)	907500
5	Hose connector VAC NIST (A-WGU side)	90717
-	Hose connector angled with red hat (fit to red hose and A-CC)	90662
-	Fresh gas hose angle connector with locking device	8500935
-	Gas hose O-ring, for NIST	65399*
-	Nut for EVAC connector 90714	90713
-	Nut for hose connectors NIST	90719

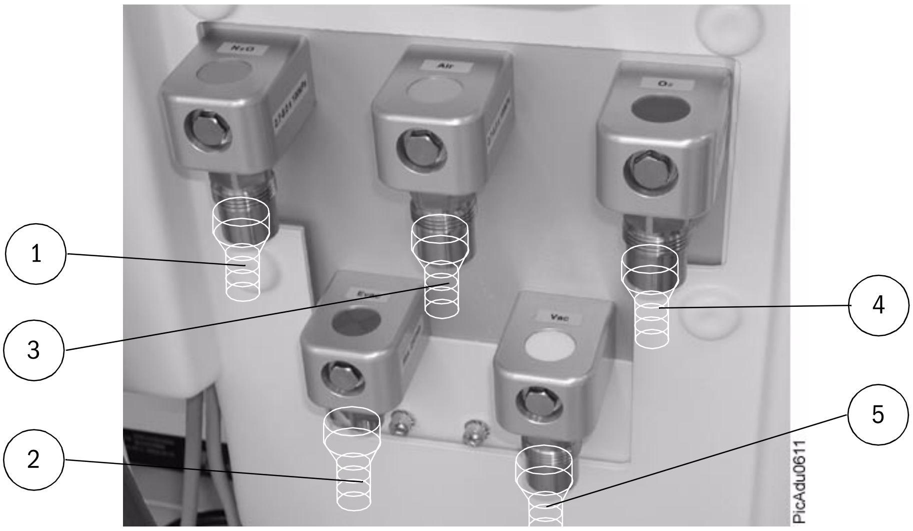


Figure 54 Hose connectors (stylized)

Connector hat for auxiliary gas outlets AGA type

Item	Item description	Order No.
1	AUX. Connector hat, red	90671
1	AUX. Connector hat, green	90663
1	AUX. Connector hat, white	90664
1	AUX. Connector hat, blue	90665
1	AUX. Connector hat, black and white	90666
1	AUX. Connector hat, black	90667
1	AUX. Connector hat, grey	90669
1	AUX. Connector hat, yellow	90670

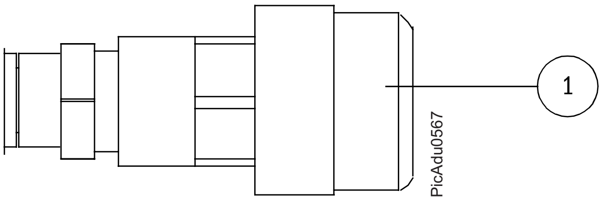


Figure 55 **AGA type gas outlet**

Male connectors for female auxiliary quick connectors

Item	Item description	Order No.
1	Air quick connector AGA-type male quick connector for air outlet, A-AXA1 or air outlet, right hand, A-AXAR	735028
2	O_2 quick connector AGA-type male quick connector for oxygen outlet, A-AXO21	735027
3	Vacuum quick connectors DAMECA 31202B type male straight connector for Di = 6 mm vacuum O_2 hose	735105

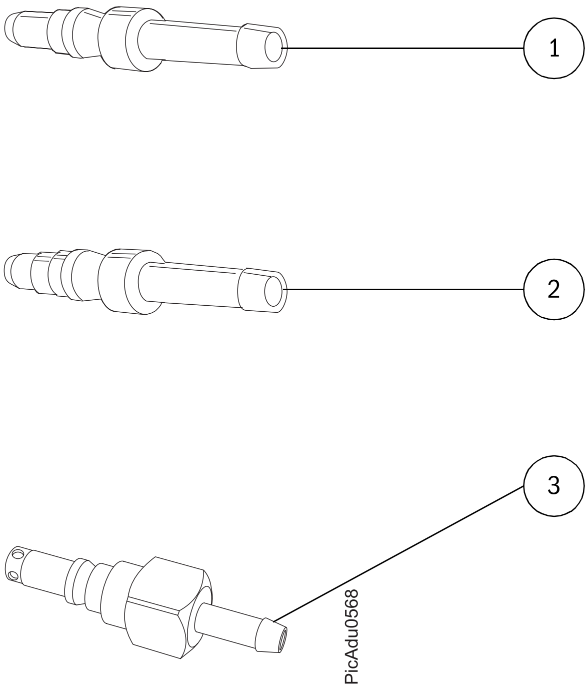


Figure 56 Male gas connectors

A-SEJ2 and flow indicator

Table YES (Y) = To replace the spare part the A-WGU should be removed from frame.

Table NO (N)= Spare part can be installed without removing the A-WGU from frame.

Item	Item description	Order No.	Y	N
--------	A-SEJ2, includes flow indicator (fits A-WGU-00 also if Frame gas inlet P/N 8500732 is order).	A-SEJ2	X	
---------	Scavenging Flow indicator	8500100	X	
1	A-SEJ2 Knob	884401		
2	Knob screw needle valve A-SEJ2	61956*		X
3	Label flow indicator	886891		X
4	Needle valve NOTE: Needle valve mounted on washer (see Figure 58 on page A-63) is not possible to exchange.	8502638		X
5	A-SEJ2 knob (old version)	888079*		X

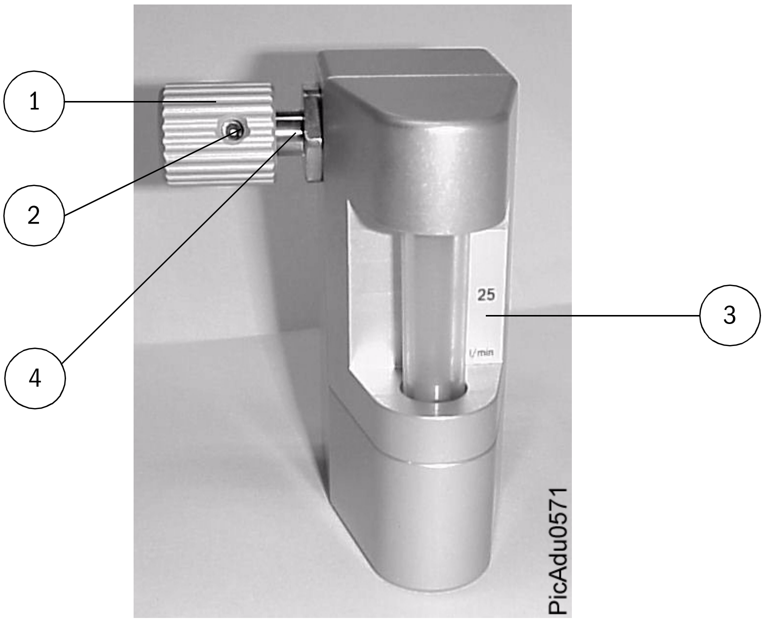
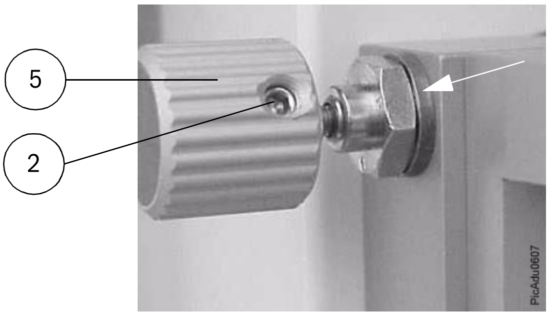


Figure 57 A-SEJ2 and flow indicator



NOTE: Needle valve mounted on washer is not possible to exchange

Figure 58 A-SEJ2 old version

Scavenging flow tube repair kit

Item description	Order No.
Scavenging flow tube Repair kit Includes item 1-4	8502494

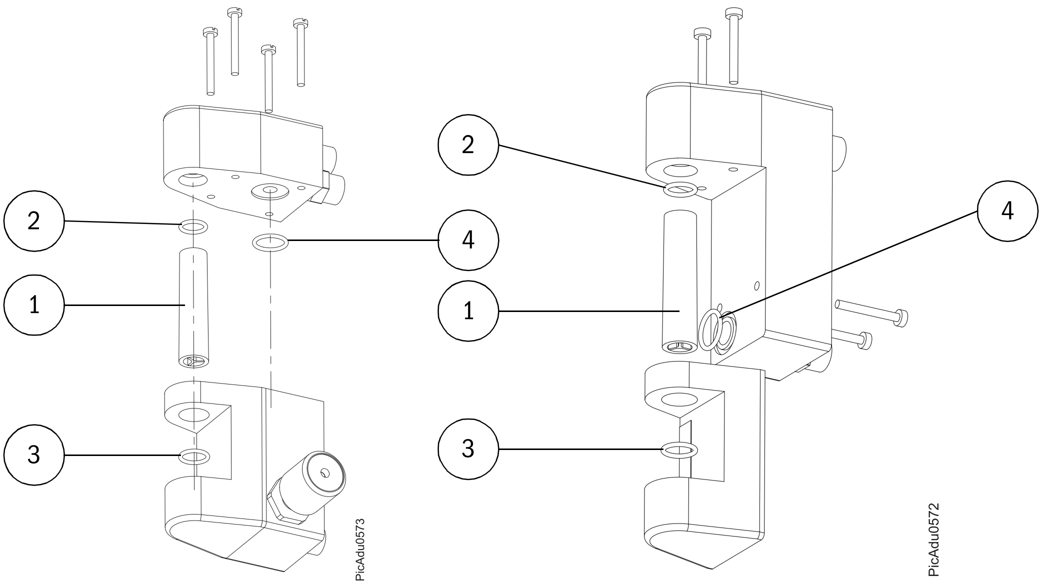

2
1
3
4
PicAdu0573
2
4
1
3
PicAdu0572

Figure 59 **Scavenging flow tube**

Copper pipes for yoke(s)

Item	Item description	Order No.	Y	N
401	Copper pipe	8503401	X	
402	Copper pipe	8503402	X	
403	Copper pipe	8503403	X	
426	Copper pipe	8503426	X	
427	Copper pipe	8503427	X	

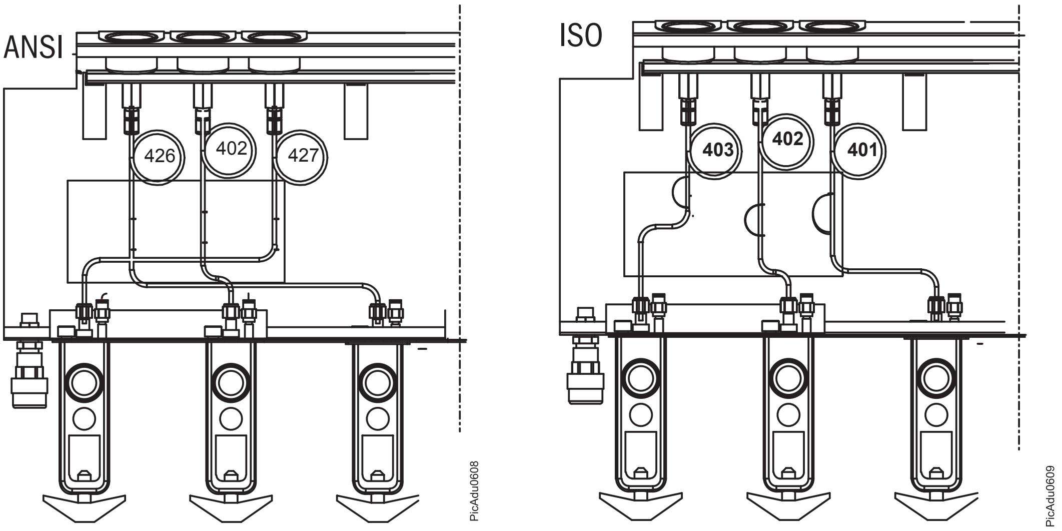

ANSI
426
402
427
PicAdu0608
ISO
403
402
401
PicAdu0609

Figure 60 **Copper pipes for yokes**

Wall gas unit multiconnectors and silencer

Item	Item description	Order No.
1	Multi connector gasket, WGU right hand side	893162
2	Multi connector gasket, WGU left hand side	893163
3	Multi connector WGU left hand side	889654
4	Multi connector WGU right hand side	889653
5	Silencer	8502504

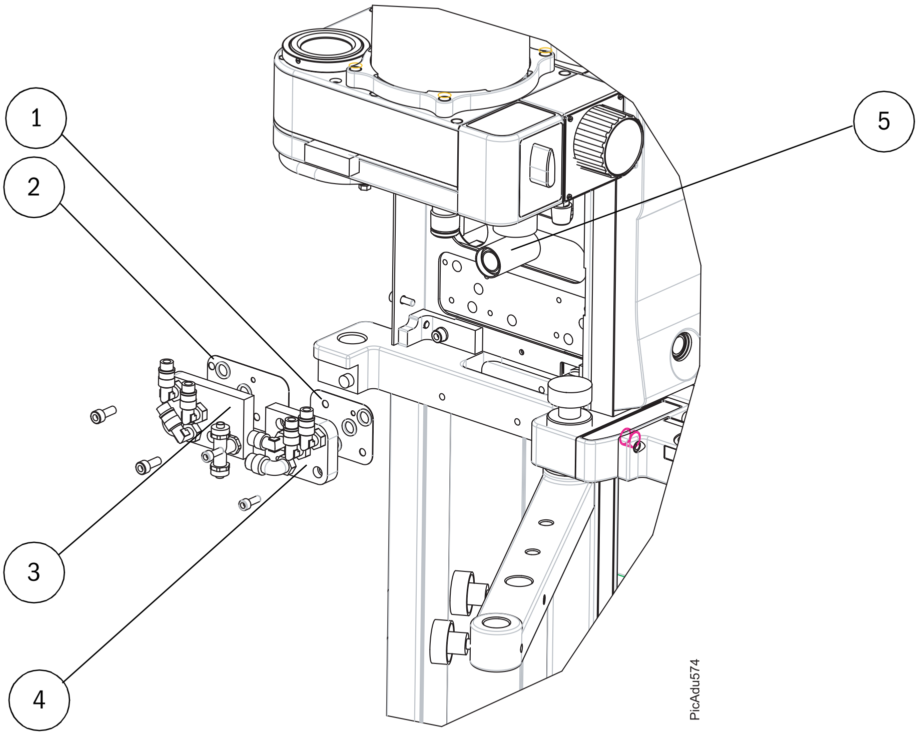


Figure 61 **Exploded view of the Wall Gas Unit multiconnectors and silencer**

Yokes

Item	Item description	Order No.
1	Seal sticker / Yoke and safety valve	881693*
2	Yoke sealing / PIN black N_2O	90702*
2	Yoke sealing / PIN Red O_2 and Air	90703*
3	Yoke filter / PIN	90712*
-	Yoke sealing / DIN	90711*
-	Yoke filter / DIN	90704*
-	Tool M32 / Yoke DIN	57508*
-	Cylinder key with chain	8500050*
5	Cylinder support plate standard (1 piece)	892868
6	Cylinder support plate for cylinders with large diameter. The support plate can only be used for supporting two gas cylinders mounted as the figure below shows. One support plate is needed for each gas cylinder. If only one gas cylinder is used, the plate can be positioned in optional position.	8501842

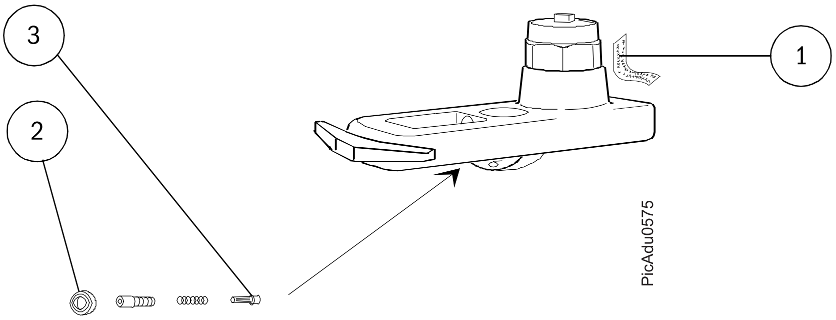


Figure 62 **Yoke**

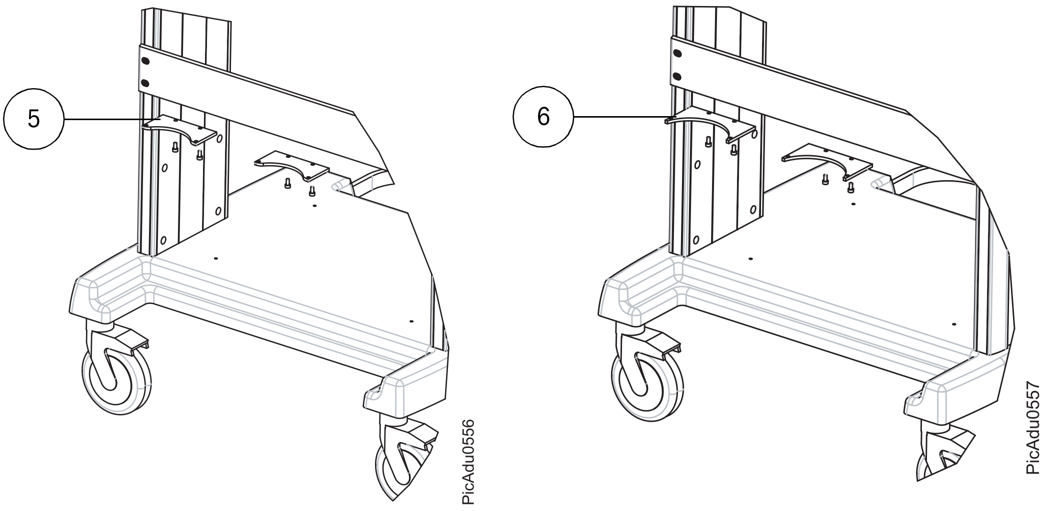


Figure 63 **Cylinder support plates**

Yoke regulators maintenance kit

Item	Item description	Order No.
See below	Repair kit for yoke regulators (including Seal sticker)	8502306

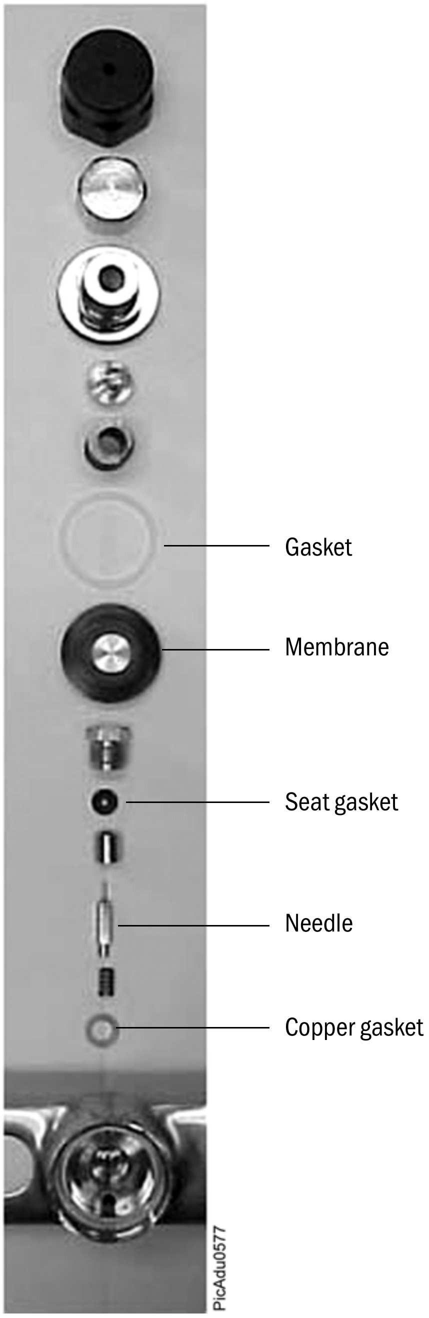

Gasket
Membrane
Seat gasket
Needle
Copper gasket
PicAdu0577

Figure 64 **Parts included in repair kit for yoke regulator**

Circuit arm (from A-AUF ID: No. 40007637)

Item	Item description	Order No.
---------	Circuit arm complete including knobs	8500200
1	Knob, patient circuit arm	888455*
2	Cover	889448
3	Locking ring	63822
4	Washer	8500197
5	Sleeve (white),	8500196
6	Sleeve guide	8500195

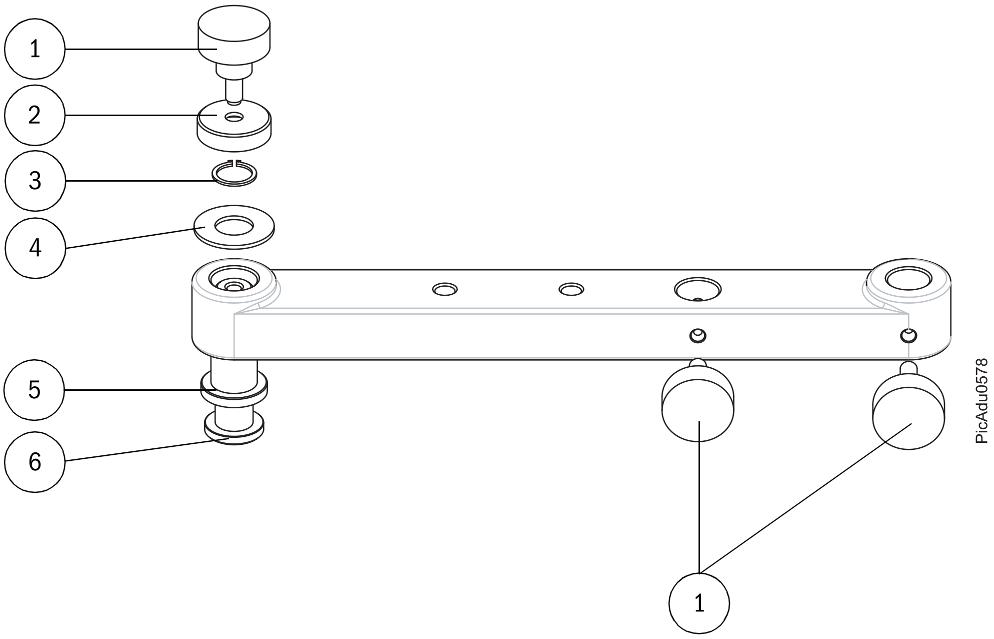


Figure 65 Circuit arm

Circuit arm (below A-AUF ID: No. 40007637)

Item	Item description	Order No.
1	Knob	888455*
2	Cover	889448
3	Locking ring	63822
4	Sleeve (black)	889444
5	Circuit arm	889445
6	Lower Washer	890160

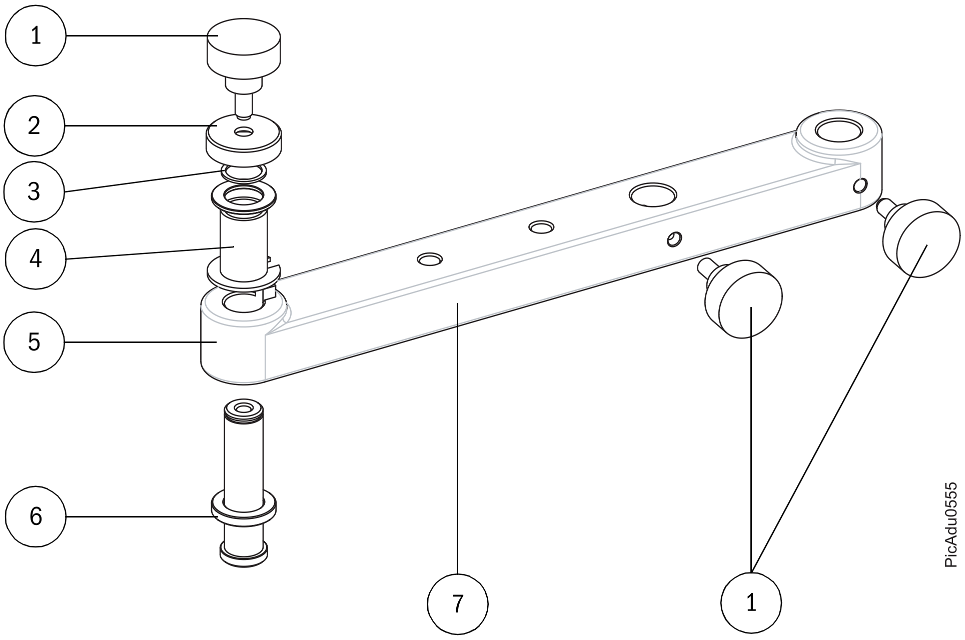


Figure 66 Circuit arm (below A-AUF ID: No. 40007637)

Cable management arm

Item	Item description	Order No.
1	Fitting ring for inner tube	888830
2	Clamp for breathing tube	888831
3	Clamp for sampling line and wire	888832
4	Nut for holding item 3 (use loctite to secure)	889621
-	Complete arm	888090

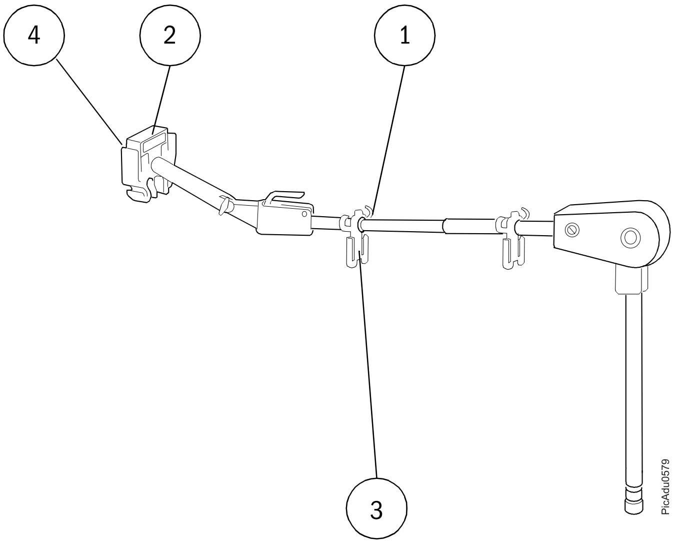


Figure 67 **Exploded views of cable arm**

Cable holder

Item	Item description	Order No.
1	Cable holder	8502472
2	Cable holder rubber servicing kit (includes 10 pieces)	8502440

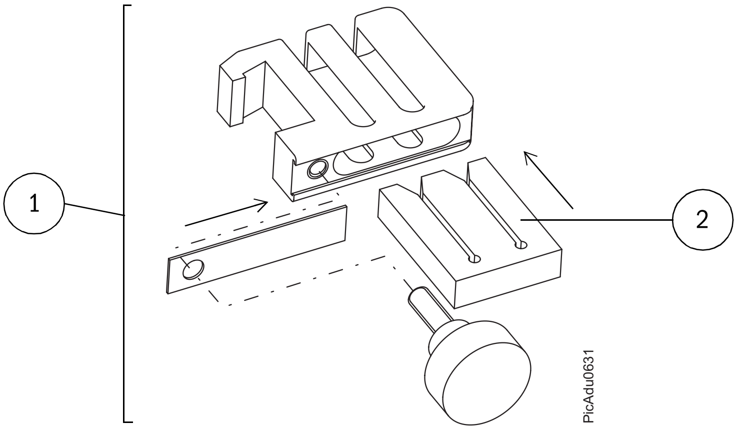
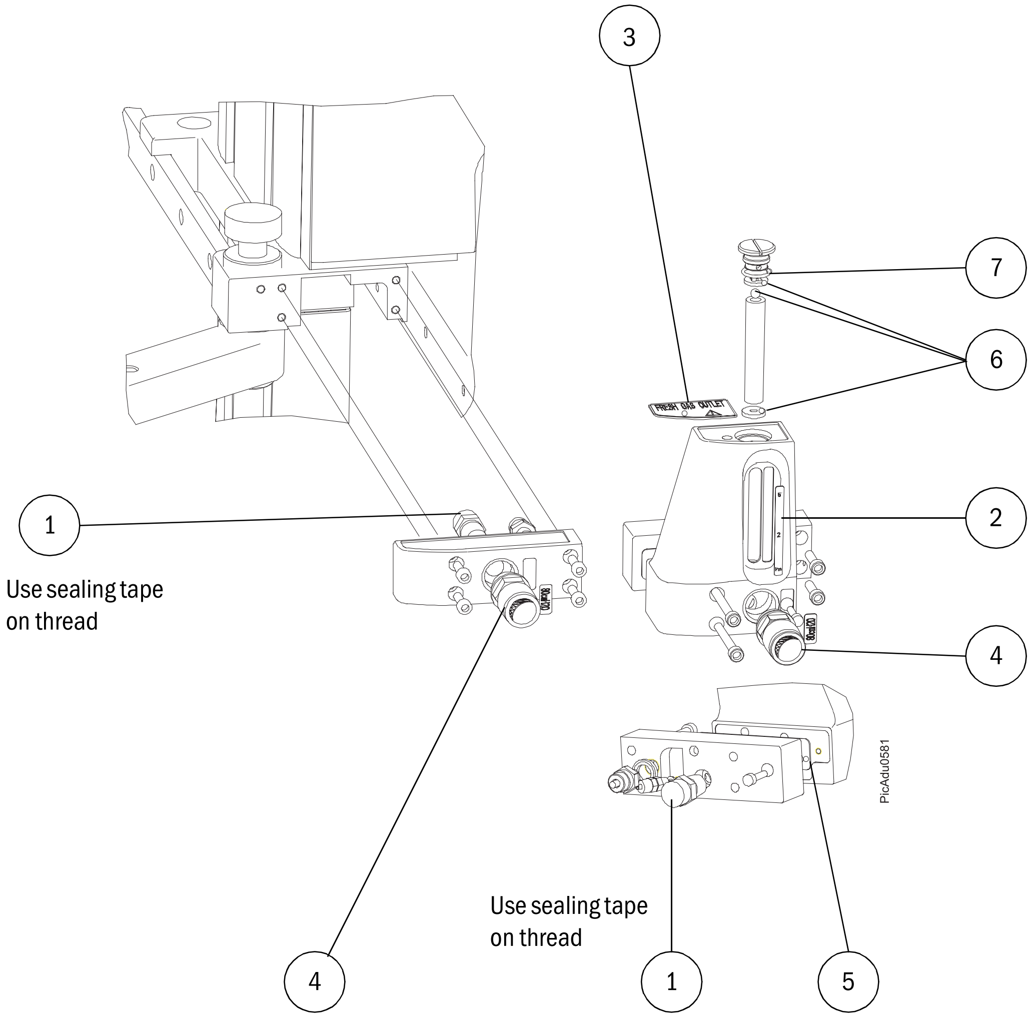


Figure 68 **Cable holder**

Fresh gas outlet and flow indicator A-FGFI

Item	Item description	Order No.
1	Safety valve for Fresh Gas Outlet (Also fits unit without A-FGFI)	8500942
4	Fresh gas outlet cone with O-ring	8500941
5	Gasket A-FGFI	8500821
7	O-ring	65639
3,6	Repair kit Flow tube with ball	8500962

Note:
Large diameter of tube upwards.
Protection for ball and tube
removed



Use sealing tape
on thread

Use sealing tape
on thread

Figure 69 Exploded view of fresh gas outlet and flow indicator A-FGFI

Fresh gas outlet label with or without A-FGFI

Without					
Text on label	**Order No.**	**Text on label**	**Order No.**	**Text on label**	**Order No.**
FRESH GAS OUTLET	891894	FRISCH GAS AUSLASS	891895	SORTIE GAZ FRAIS	891896
VERS GAS UITGANG	891897	FÄRSKGASUTGÅNG	891898	USCITA GAS FRESCHI	891899
SALIDA DE GAS FRESCO	891900	FÄRSKGASUTGÅNG /TUOREKAASU ULOSTULO	893842	FRISKGASSUTTAK	8500216
SAÍDA DE GÁS FRESCO	8500504	FRISKGAS UDTAG	8500793		
With					
Text on label	**Order No.**	**Text on label**	**Order No.**	**Text on label**	**Order No.**
FRESH GAS OUTLET	8500781	SALIDA DE GAS FRESCO	8500785	FRISKGASSUDTTAG	8500789
FRISCHGASAUSLASS	8500782	USCITA GAS FRESCHI	8500786	FÄRSKGASUTGÅNG /TUOREKAASU ULOSTULO	8500790
SORTE GAZ FRAIS	8500783	SAÍDA DE GÁS FRESCO	8500787	FRISKGAS UDTAG	8500791
VERS GAS UITGANG	8500784	FÄRSKGASUTGÅNG	8500788		

Hoses / tubings

Item description	Order No.
Hose, black/white (order/meters)	733460
Hose, green (order/meters)	733461
Hose, yellow (order/meters)	733462
Hose, grey (order/meters)	733463
Hose, red (order/meters)	733464
Hose, blue (order/meters)	733465
Hose, white (order/meters)	733466
Hose, blue/brown (order/meters)	733467
Hose, brown (order/meters)	733468
Transparent tube 5/3mm (order/meters)	733480
Transparent tube 8/6mm (order/meters)	733479
Transparent tube 6/4mm (order/meters)	733472

Red tube 8/6mm (order/meters)	733476
Red tube 6/4mm (order/meters)	733478

Miscellaneous parts

Item	**Item description**	**Order No.**
-	Touch up paint, AS/3 ADU	8500860
-	Touch up paint, S/5 ADU	8501443
-	Locking washer for WGU back cover locking mechanism	035404700
-	Toothed washer M5	63619
-	MC6S M5X16	619141
-	Washer M5	63415
-	MC6S M5X35	619143
1	On/Standby switch	52108
2	On/Standby LED board	893176

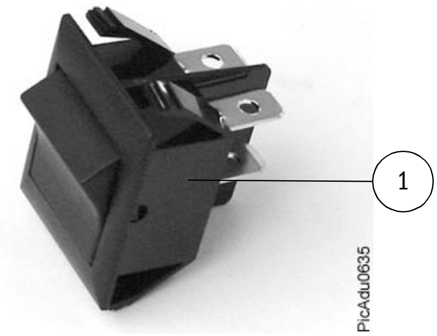


Figure 70 On/Standby switch

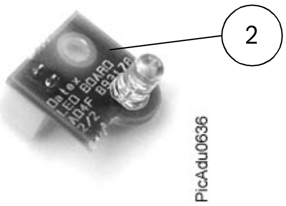


Figure 71 On/Standby LED board

TECHNICAL DESCRIPTION A-FGC1

Introduction

The A-FGC1 module is a part of the ADU, consisting of two functional parts, the flow controls and the vaporizer, integrated into one module. The A-FGC1 module mixes the breathing gases and dosages the anesthetic agent.

The main function of the flow controls is to mix two gases at a time in required ratios (O_2+ N_2O or O_2+ Air) and provide the vaporizer with carrier gas. The vaporizer consists of a replaceable agent specific liquid cassette, Aladin, and concentration control hardware and software for mixing the anesthetic agent with the gases from the flow controls. The cassette is both a reservoir and a vaporizing chamber for the liquid anesthetic agent.

The user interface of the A-FGC1 is divided between the module and the main display of the anesthesia machine. The controls that are used to operate the module, the agent concentration wheel, flow controls and Air/N_2O selector, are directly implemented into the module. The measured and controlled variables are shown on the main display of the ADU.

Connections of the module

The module is located behind the front panel of the ADU below the ventilator and the electronics module. The connections of the module are pneumatic, mechanical and electrical.

- There are mechanical connections between the frame and the module.
- There are electrical connections between the mains electronics, the Aladin cassette and the module.
- There are pneumatic connections between the wall gas unit, frame and module.

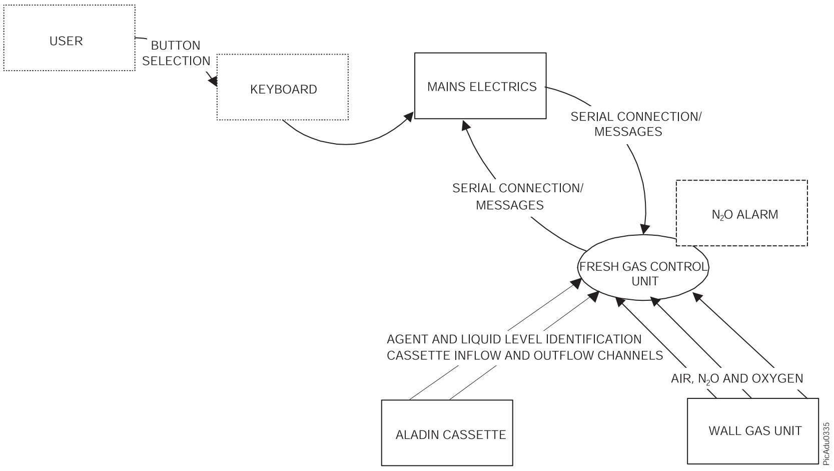

USER
BUTTON SELECTION
KEYBOARD
MAINS ELECTRICS
SERIAL CONNECTION/ MESSAGES
SERIAL CONNECTION/ MESSAGES
N₂O ALARM
FRESH GAS CONTROL UNIT
AGENT AND LIQUID LEVEL IDENTIFICATION CASSETTE INFLOW AND OUTFLOW CHANNELS
AIR, N₂O AND OXYGEN
ALADIN CASSETTE
WALL GAS UNIT
PicAdu0335

Figure 1 Connections of the Fresh Gas Control Unit

Electrical connections

The device is connected electronically with the main electronics. This connection feeds power to the module and communicates with the main electronics. The device has its own fuses. The connection is through one connector.

There is also an electrical connection between the Aladin cassette and the device, for agent identification and for liquid level measurement (desflurane). Those electrical connections consist of HALL elements for agent identification and galvanic contacts for the liquid level measurement in the desflurane Aladin cassette.

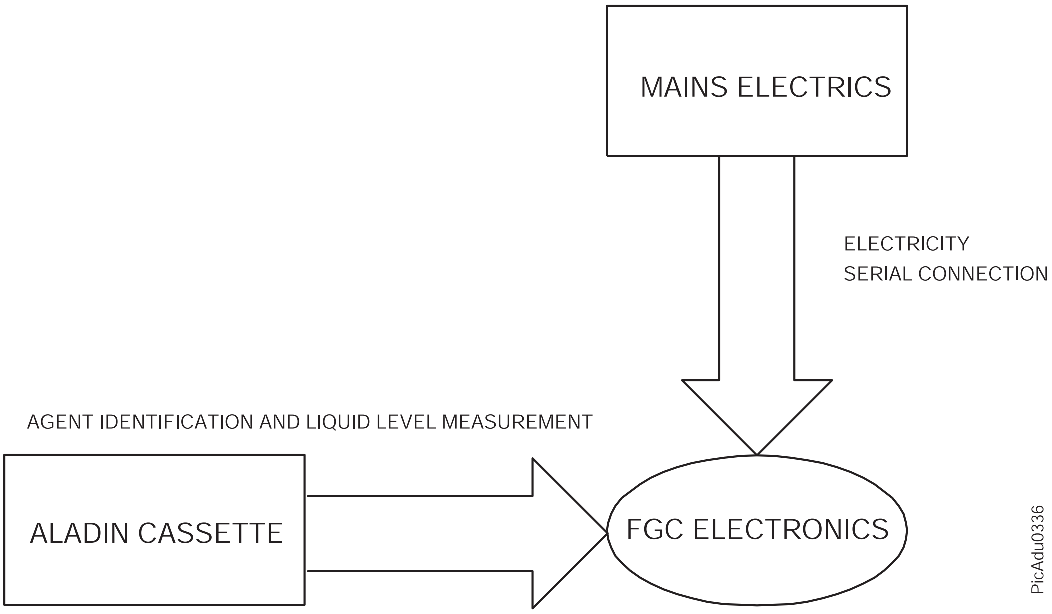

MAINS ELECTRICS
ELECTRICITY
SERIAL CONNECTION
AGENT IDENTIFICATION AND LIQUID LEVEL MEASUREMENT
ALADIN CASSETTE
FGC ELECTRONICS
PicAdu0336

Figure 2 Electrical connections of the A-FGC1

Pneumatic Connections

The module is supplied with pressurized Air, N_2O and Oxygen. All gases have the same supply pressure as the wall connector (flow losses taken into account).

The gases are filtered in the wall gas unit. There are not any non-return valves between the inside of the wall connector and the module pressure measuring point.

The module measures N_2O pressure inside the device. Measurement information is used for the ”N_2O pressure lost” alarm.

The connections between the components in the module are made from 5/3 or 6/4 mm polyamide (PA) tubing where there might be high pressures, and polythene (PE) tubing where the anaesthetic agent flows. The PA hoses are connected with O_2 compatible quick connectors (viton sealing and compatible grease). PE tubes are connected with non-rubber fittings.

Mechanical connections

The module is fixed to the frame of the ADU. Installation is done from the rear. Gases are connected from the left side (seen from the front). Gas connection is through one connector, which is connected to the tubes running from the frame (A-WGU) of the unit. Connection is of manifold-type and can be disconnected from the left side.

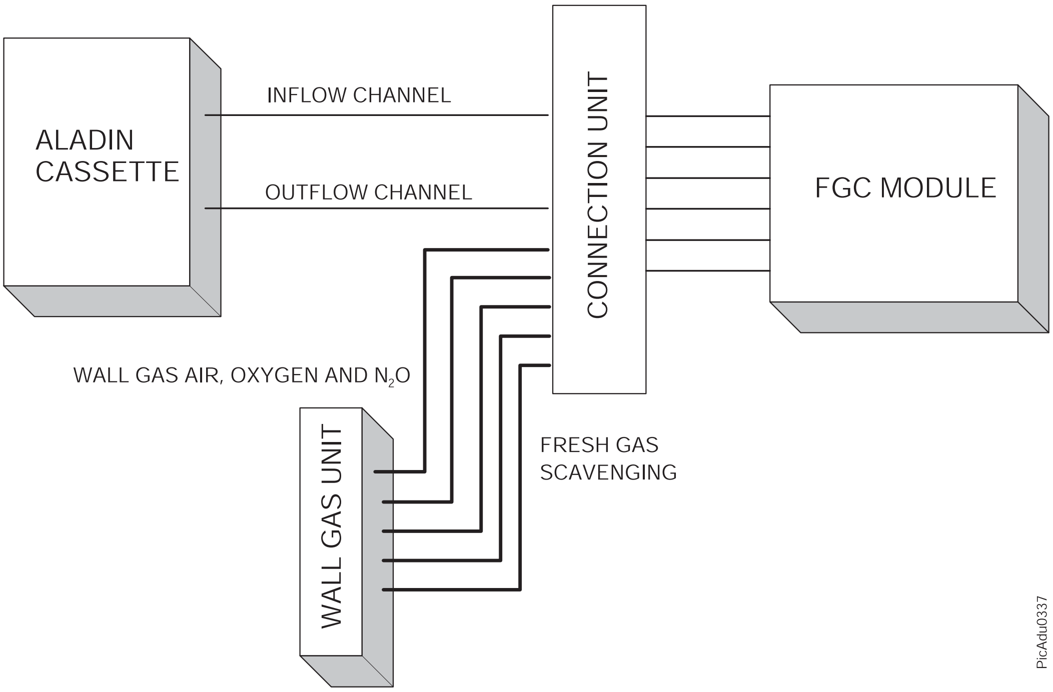
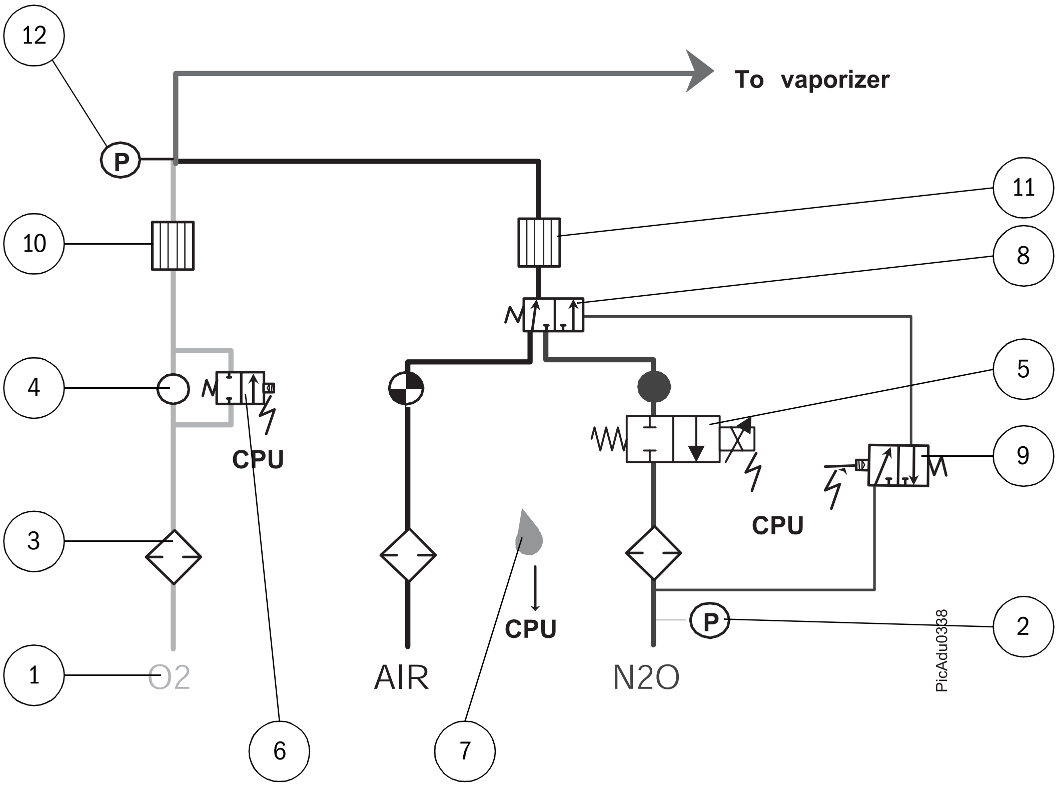

ALADIN CASSETTE
INFLOW CHANNEL
OUTFLOW CHANNEL
CONNECTION UNIT
FGC MODULE
WALL GAS AIR, OXYGEN AND N$_2$O
WALL GAS UNIT
FRESH GAS SCAVENGING
PicAdu0337

Figure 3 Technical principles of the A-FGC1

Flow controls section

Definitions of components in the flow controls section

1. Gas inlets
2. N_2O pressure sensor
3. Pressure regulators
4. Needle valves
5. N_2O proportional valve
6. O_2 test valve
7. N_2O/Air selector switch
8. N_2O/Air valve
9. N_2O/Air control valve
10. O_2 flow measurement unit
11. Side gas flow measurement
12. Counter pressure sensor



12
P
To vaporizer
11
10
8
4
5
CPU
9
3
CPU
CPU
2
P
1
O2
AIR
N2O
PicAdu0338
6
7

Figure 4 **Flow controls section**

Description of the flow control section

Pressure regulators

The fresh gas flow range is set with three regulators for each gas. The regulators control the secondary pressure to a fixed level that is independent on the pipeline pressure. The O_2, N_2O and Air lines (1) are supplied to the A-FGC1 at normal pipeline pressure and separate gas regulators (3) for each gas reduce the pressure to the gas controls of the unit.

The nominal maximum flows when the needle valves are fully open, are 14 l/min. for O_2 and Air and 12 l/min. for N_2O. The allowed flow range is 12 - 16 l/min. for O_2 and Air. For N_2O the range is 8.5 - 11 l/min. with a simultaneous O_2 flow of 4 l/min.

The flow decreases when another gas is added. The second flow increases the counter pressure that causes the regulator to decrease the flow to keep the secondary pressure at a constant level. The effect is specified in the *"Technical specifications"* section.

Flow controls and flow measurement

The flows are adjusted by means of mechanical needle valves (4) and electrical flow measurement unit's measures the gas flows.

There are two different combinations of needle valves on the front panel, ISO and ANSI. The combination, color and the shape of the control knobs is dependent on the regulatory requirements in each country.

The needle valves are linear. One full turn corresponds approximately to a 2-3 l/min. change of the flowrate. The needle valve adjustment should be smooth without any sticking and/or sudden changes in the flow.

There is one flow measurement unit for the O_2 flow (10) and one unit for the N_2O/Air flow (11), called sidegas. The sidegas sensor is calibrated for both gases. The N_2O flow may be adjusted up to 75% of total flow which assures a minimum of 25% O_2 in the fresh gas outlet.

The flow measurement units determine the gas flow from the pressure difference caused by a flow restrictor. By using a zeroing valve, which pneumatically short circuits the differential pressure sensor ports periodically, the zero pressure signal is compensated for the pressure sensor temperature drift. The same types of flow measurement units are used in the vaporizer.

Each flow measurement unit has a:

- Pressure Sensor Board

The output voltage of the pressure sensor (tens of millivolts) is amplified to a level which is suitable for the A/D converter in the CPU board of the fresh gas control unit. The gain of each amplifier is set according to the type of the sensor being used and the pressure signal of the measurement unit.

- Flow Restrictor

The gas flow in the flow restrictor is close to laminar thus causing a pressure difference linear to the flow. The restrictor causes a pressure drop that is measured by the pressure sensor. The pressure difference is then used to calculate the flow through the flow measurement unit. The mixer flow measurement units are designed to give the maximum signal (10V) at 20 l/min. A 15 l/min. flow produces nominally a 140 mbar pressure drop over the flow restriction.

- Zeroing Valve

A zeroing valve is used to compensate the pressure sensor temperature drift that causes variation of the zero point signal. The valve connection is shown in the figure. In powered position the pressure sensor ports are pneumatically connected thus giving the zero pressure signal. In the normal position (no voltage), the sensor ports are connected to opposite sides of the restriction. The valve compensates pressure sensor zero drift and is connected to two lines. One line is upstream the flow restrictor, the other line is downstream. The valve can pneumatically short-circuit the pressure sensor ports, thus giving the zero pressure (= zero flow) signal. Both the zeroing valves are connected to zero 1 circuit.

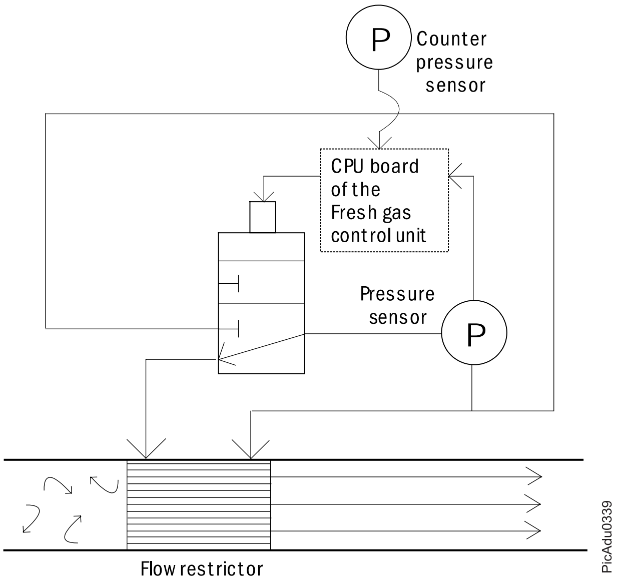


Figure 5 **Electrical Flow Measurement Unit**

N_2O limiting control

The N_2O limiting control of the A-FGC1 calculates continuously the maximum allowed N_2O flow using the current O_2 flow as input. If the N_2O needle valve, see (4) Figure 4 on page B-4, is opened to a position that would cause a flow higher than the maximum calculated, a proportional valve (5) reduces the N_2O flow so that a minimum of 25% O_2 is achieved. The sw uses the proportional valve to control the O_2 concentration in the fresh gas.

The proportional valve (5) is a linear current driven proportional valve located after the N_2O needle valve before the N_2O/Air selection valve. The current is controlled with the 12 bit DAC on the CPU board. The valve control is calibrated. The calibration procedure is described later in this section.

N_2O/Air selection

With the N_2O/Air switch (7) the user may select either N_2O or Air to be mixed with O_2. The selector switch (7) transmits the switching information (N_2O /Air) to the CPU board of the fresh gas control unit. The N_2O/Air control valve (9) selects N_2O or Air to be mixed with O_2 according to the information from the CPU of the fresh gas control unit. In power off situation, the N_2O/Air valve (8) N is al-ways in Air position.

When the N_2O/Air selector switch is in N_2O position the CPU opens the N_2O/Air control valve and thereby switches N_2O gas pressure to the N_2O/Air valve, which is pneumatically driven by the N_2O gas pressure (2). The N_2O gas flow can then be mixed with O_2 flow according to the needle valve settings and the N_2O proportional valve.

The N_2O/Air selection valve (8) is a 5/2 pneumatically driven piston valve. The N_2O/Air control valve (9) pilot valve is an electrical driven 2/2 solenoid valve that drives the selection valve (8). Both valves is integrated into the N_2O/Air selection valve

N_2O pressure sensor

The N_2O pressure sensor (2) supervise the N_2O pipeline pressure to the A-FGC1. If the pressure falls below 2.5 bar will the alarm ´N_2O supply pressure lost´ be initiated. In the same time will the N_2O gas delivery be cut-off and Air will automatically be selected by the N_2O/Air valve (8).

The N_2O pressure sensor is a differential semiconductor sensor. It is located in the regulator block pneumatically before the N_2O regulator.

The output voltage of the sensor is amplified and filtered on the board. The filter is a low pass filter with a cut off frequency of 10 Hz

The sensor measures the differential pressure between ambient air and the N_2O pressure line. The pressure range is within 0-8 bar. The sensor does not need a zeroing function.

The sensor calibration is described in the calibration chapter.

O_2 test valve

The flow controls also contain an O_2 test valve (6), which is used only when carrying out system check. The valve is an On/Off valve, which bypasses the manual O_2 needle valve. The test flow is typically 5-7 l/min. The O_2 test valve is used for automatic delivery of oxygen.

The O_2 Test valve is a 2/2 solenoid valve and a fixed restrictor in the flow channel determines the test flow after the valve. The restrictor is an Allen screw with a round orifice.

Counter pressure

A counter pressure sensor (12) measures the exit pressure of the flow control section. The measured counter pressure is used for calculating the flow to ambient pressure conditions and also for occlusion detection during normal operation.

The counter pressure is needed for flow calculations.

The pressure sensor is a differential semiconductor sensor. It is located in the flow measurement block pneumatically after the O_2 and sidegas and before the bypass flow measurements.

The output voltage of the sensor is amplified and filtered on the board. The filter is a low pass filter with a cut off frequency of 10 Hz.

The sensor measures the differential pressure between ambient air and the flow measurement block. The pressure range is within 0-1 bar. The sensor does not need a zeroing function.

The sensor calibration is described in calibration chapter.

Vaporizer section

Theory of the vaporizer

The electronically controlled vaporizer is integrated with the gas flow controls in the A-FGC1 module. When the vaporizer is used, the gas flow from the flow controls is split into a bypass flow and a liquid chamber flow i.e. Cassette flow. The agent vaporizes freely in the liquid chamber without any active heating or pressurization that means that the vaporizer can be categorized as a combination of conventional variable bypass and measured flow vaporizers.

The operator sets the anaesthetic concentration with the Agent wheel and the cassette flow controller controls the concentration in the fresh gas outlet.

The essential principle used in the A-FGC1 vaporizer is that the saturated vapor pressure of the anaesthetic agent is dependent on the temperature of the liquid agent. By continuously measuring the temperature and the cassette pressure inside the liquid chamber of the Aladin cassette, the anaesthetic agent concentration in the liquid chamber is always known.

The agent concentration in the fresh gas outlet of the A-FGC1 module is a function of the agent concentration in the cassette and the ratio of the cassette outflow and the bypass flow measurement unit which are measured continuously. The target parameter for the agent controller is the set flow ratio (setr) which is calculated from the required agent concentration in the fresh gas outlet (setaa) and the current agent concentration inside the cassette (pvapor/pcassette).

The set flow ratio is also compensated with the ambient pressure which means that the vaporizer output concentration increases as the ambient pressure decreases. The effect is similar to traditional vaporizers, thus a compensation factor directly proportional to the ratio of sea level pressure (psealevel) and current atmospheric pressure (pambient) is used in the calculations. This yields that the set flow ratio is calculated in the following way:

$$\mathrm{setr} = \frac{\mathrm{compaa}}{100 \cdot \left(\frac{P_{\mathrm{vapor}}}{P_{\mathrm{cassette}}}\right) - \mathrm{compaa}}$$

where

$$\mathrm{compaa} = \frac{P_{\mathrm{sealevel}}}{P_{\mathrm{ambient}}} \cdot \mathrm{setaa}$$

The controlled parameter is the measured flow ratio (measr), which is the ratio of the measured liquid channel (F_{liqch}) and bypass flow (F_{bypass})

$$\mathrm{measr} = \frac{F_{\mathrm{liqch}}}{F_{\mathrm{bypass}}}$$

The concentration in the fresh gas outlet is controlled by the position of the agent proportional valve, which is set continuously according to the information from the agent controller.

The gas composition of the bypass flow and the gas entering the vaporizer is known and it is used to compensate the flow transducer output, which means that the gas composition has no effect on the anaesthetic output or accuracy as it has in conventional vaporizers.

The Bypass flow and the Cassette outflow (= Fresh Gas Flow) are then passing a mixing chamber before reaching the Fresh gas outlet.

Definitions of components in the vaporizer section

1. Bypass flow measuring unit
2. Cassette flow measuring unit
3. One way valve
4. Cassette inflow closing valve
5. Cassette outflow closing valve
6. Cassette pressure sensor
7. Agent proportional valve
8. Scavenging valve
9. Aladin Connection
10. Temperature sensor
11. Cassette identification board
12. Liquid level measurement board
13. Fan
14. Liquid flow prevention valve
15. Mixing chamber
16. Scavenging chamber
17. Flow restrictor

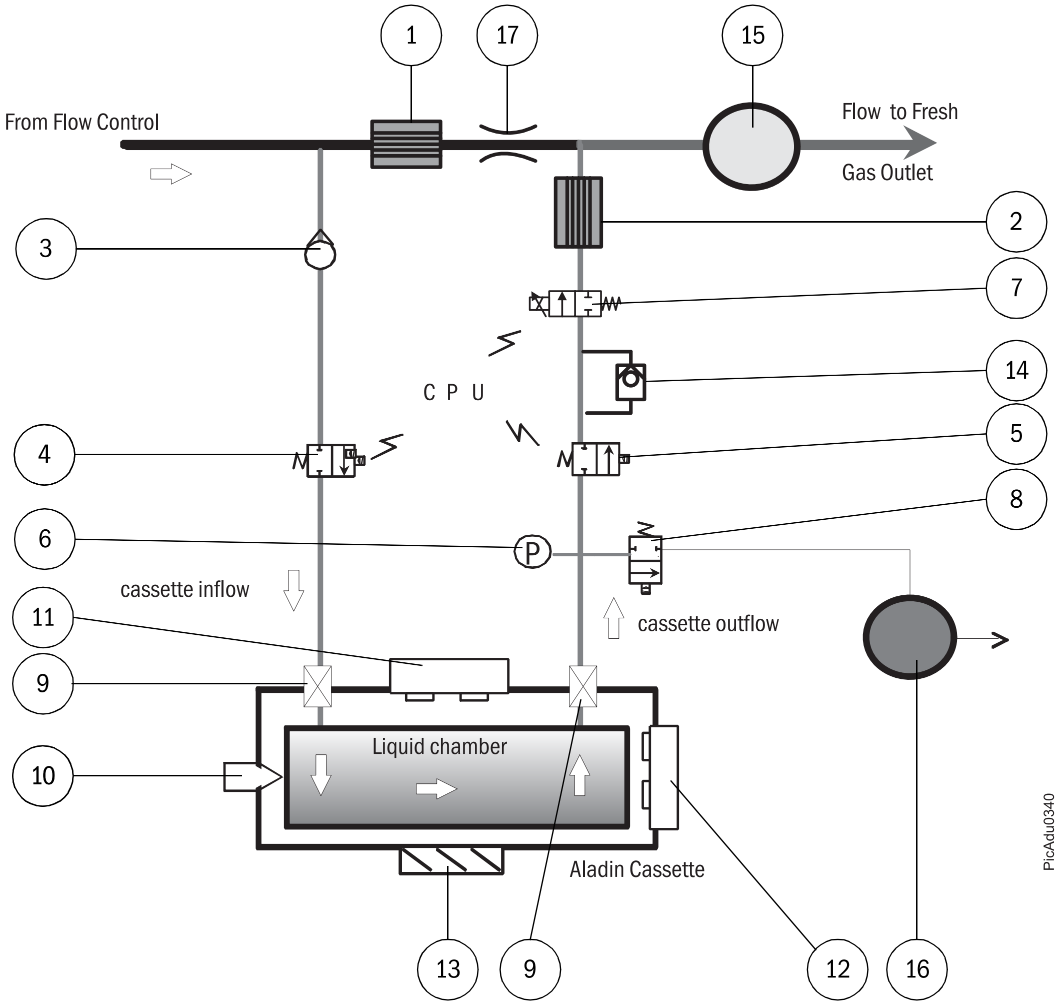

1
17
15
From Flow Control
Flow to Fresh
Gas Outlet
2
3
7
14
C P U
4
5
8
6
P
cassette inflow
cassette outflow
11
9
Liquid chamber
10
Aladin Cassette
PicAdu0340
13
9
12
16

Figure 6 **Electronically controlled vaporizer**

Agent control

The fresh gas from the flow controls is divided into:

- The bypass flow measured by the Bypass flow measurement unit (1)
- The cassette outflow measured by the Cassette flow measurement unit (2)

The cassette and bypass flow measurements are used to control the vaporizer output and for safety purposes to check the validity of the mixer flow measurements. The common details of the Bypass and Cassette flow measurement units are described in the flow controls section.

The vaporizer flow (Cassette flow) measurement unit is designed to give the maximum signal (10V) at 5 l/min. The pressure drop in the block will then be nominally 40 mbar. The lowest measurable flow is 0.5 ml/min. that roughly corresponds to an anaesthetic concentration of 0.1% Isoflurane at a fresh gas flow of 250 ml/min. A 5 l/min. flow roughly corresponds to an anaesthetic concentration of 8% Sevoflurane at 10 l/min. fresh gas flow.

The bypass flow measurement is designed to give the maximum signal (10V) at 30 l/min. A 15 l/min. flow produces nominally a 185 mbar pressure drop in the block.

Both zeroing valves are connected to the zero2 circuit.

When the vaporizer is off, the Bypass flow is equal to the sum of the O_2 and Side gas flows.

Agent concentration is altered by adjusting the cassette outflow.

The flow restrictor (17) of the bypass flow measuring unit generates the pressure upstream the flow division point.

When the vaporizer is on and an agent concentration is set, the cassette inflow and outflow closing valves (4 and 5) are open and a part of the flow goes through the ADU Aladin cassette liquid chamber, where the agent is vaporized.

The Cassette outflow is adjusted by the Agent proportional valve (7) which is controlled from the A-FGC1 CPU board.

The valve is a linear current driven proportional valve located just before the cassette flow measurement. The current is controlled with the 12 bit DAC on the CPU board. There is a heater resistor mounted beside the valve to ensure that there is no condensation inside the valve. The Agent proportional valve response to flow is calibrated. The calibration procedure is described in the calibration section.

The Cassette outflow is then mixed with the Bypass flow.

The Bypass flow and the Cassette outflow (= Fresh Gas Flow) are then passing a mixing chamber before reaching the Fresh gas outlet.

Cassette flow channel pneumatics

When the Aladin cassette is inserted into the A-FGC1 unit, the spring loaded valves are opened in the connection (9) between the liquid chamber and the inflow and outflow channels of the Vaporizer.

The cassette inflow and outflow channels both have electrically driven valves (4, 5).

The inflow (4) and outflow (5) closing valves will close the flow channels automatically and are, in error situations, rapidly cutting off the anaesthetic agent delivery.

The Mixing chamber (15) is used to stabilize the agent concentration output as the back pressure fluctuations caused by the ventilator, otherwise will cause oscillation at the fresh gas outlet.

The one way valve (3) is to prevent an uncontrolled anaesthetic gas flow from the cassette through the inlet tubing to the fresh gas flow. There is also software based one way valve for double the security of preventing back flow from the liquid flow channel.

The liquid prevention valve (14) prevents liquid from the cassette to enter the fresh gas line in a failure situation. The valve is a polypropylene ball located in the vaporizer valve block beside the outflow channel. The liquid will lift the ball up and seal it to the valve seat.

The cassette pressure relief valve (8) opens the channel to the scavenging line, if a high pressure is detected in the cassette or the liquid level measurement device detects overfilling.

The scavenging chamber (16) is used as a buffer for a possible release of anaesthetic liquid from the Aladin cassette. This is in order to prevent the tubing to be filled with liquid if the scavenging valve has opened due to an overfilled Aladin cassette.

Agent concentration control

The green LED on the front panel beside the agent wheel is used to indicate that the vaporizer is on. The A-FGC1 CPU switches on the agent LED when the anaesthetic concentration is set above zero.

The agent concentration is set by turning the agent wheel. The agent wheel operates a digital potentiometer that gives signal pulses to the A-FGC1 CPU. There are two inputs to the CPU I/O ports. The rotation direction is detected from the phase of these two signals. The amount of pulses is calculated and converted to set concentration.

Software sets the agent concentration according to the number of output pulses from the agent wheel.

By measuring the pressure and the temperature in the cassette, thereby knowing the agent concentration, the correct cassette flow can be calculated to achieve the set concentration.

- Anaesthetic agent identification

Anaesthetic agent type is detected by a cassette identification sensor board (11) The cassette identification sensor is located at the top, inside the cassette slot. It consists of five HALL sensors, one for each Aladin cassette magnet position. The configuration of two magnets in five possible positions, identifies agent type.

- Liquid temperature

The temperature is measured by two curve-fitted NTC thermistor sensors. The resistors are mounted into a conical gold plated copper piston that makes a thermal connection with the Aladin temperature measurement rod (10). The resistors are connected so that a short circuit, ground connection or cross connection between the sensors is detected by the A-FGC1 software. If the temperature measurement is defective, an alarm is displayed and vaporizing is continued, using a default value of 45° Celsius. The sensors are calibrated. The procedure is described in the calibration section.

A fan (13) is mounted inside the fresh gas control unit underneath the Aladin housing and is required to heat the cassette when using high concentrations as vaporizing cools the cassette. In practise only needed when Desflurane is vaporized.

The fan operates when the cassette temperature is below 17^{o} C and stops when the temperature is above 20 ^{o}C

- Cassette Pressure

The cassette pressure (6) is measuring the pressure in the cassette outflow channel. If the pressure is above 1200 mmHg (1.6 bar), the scavenging valve is opened.

Desflurane liquid level measurement

The Desflurane Aladin Cassette has a built in electronic liquid level measuring device (12). If the cassette is overfilled, the scavenging valve (8) is opened and the O_2 test flow is used to flush the extra agent liquid out of the cassette through the valve. Agent delivery will be cut off and has to be restarted.

If the cassette is empty or overfilled, a user alarm is displayed:

If the cassette is overfilled to a 160% according to maximum limit (100% = 250 ml), the alarm message 'Draining Cassette´ is displayed. The alarm message will disappear when the cassette is 120% over the maximum limit.

If there is less than 10% of liquid (25 ml approximately) left in the cassette, the alarm message ´Cassette Empty´ is displayed.

Liquid chamber, Aladin Cassette

The liquid chamber flow is conducted into the Aladin Cassette, which is the only agent specific part of the vaporizer. The agent cassette contains liquid agent, which is vaporized when the gas flow passes through the cassette. It can be categorized as a flow-over vaporizer, using wicks inside the cassette to increase the surface area. The large vaporizing surface in the liquid chamber guarantees that the agent flowing through is vaporized over the entire operating range.

Each Aladin cassette is magnetically coded for its specific agent. There is a cassette identification sensor board (11) with five Hall sensors in the cassette housing which identifies a unique combination of magnets for every anaesthetic agent. By using a combination of two magnets in five positions in the cassette, an erroneous identification is avoided in any single sensor failure case. The name field of the anaesthetic agent on the main screen is updated according to the name and the color of the cassette.

There are keyed filling systems for filling the cassette with anaesthetic agent. A level window indicates the amount of liquid in the cassette and for the Desflurane cassette there is also an electronic liquid level measurement. Changing the Aladin cassette in the vaporizer cassette housing easily changes anesthetic agent.

The cassette does not include any flow channels for the bypass gas flow which means that the liquid cannot escape in any hazardous positions during handling. No specific attention to the carrying position of the cassette is required.

Aladin Cassette

Different Aladin cassettes are needed for different agents and keyed filling systems.

Halothane A-VHAL, Isoflurane A-VISO, Enflurane A-VENF, Sevoflurane A-VSEV, Sevoflurane A-VSEVQ and Desflurane A-VDES.

The Aladin locking mechanism locks the cassette firmly into the cassette slots. The connection is automatic when the cassette is pushed into locked position.

The cassette is unlocked by squeezing the trigger in the handle.

Since the cassette does not include any flow channels for the bypass gas flow, the liquid cannot escape in during handling. This means that no special attention, as to the position of the cassette when it is carried, is required.

The large vaporizing surface in the liquid chamber guarantees that the agent flowing through is vaporized over the entire operating range.

All Aladin cassettes are equipped with a liquid level window where a ball changes its position depending of the amount of liquid in the cassette.

When the ball is in top position, the cassette contains about 250 ml, whereas the cassette contains about 80 ml with the ball in bottom position.

The diagram below shows the parts common to all Aladin cassettes.

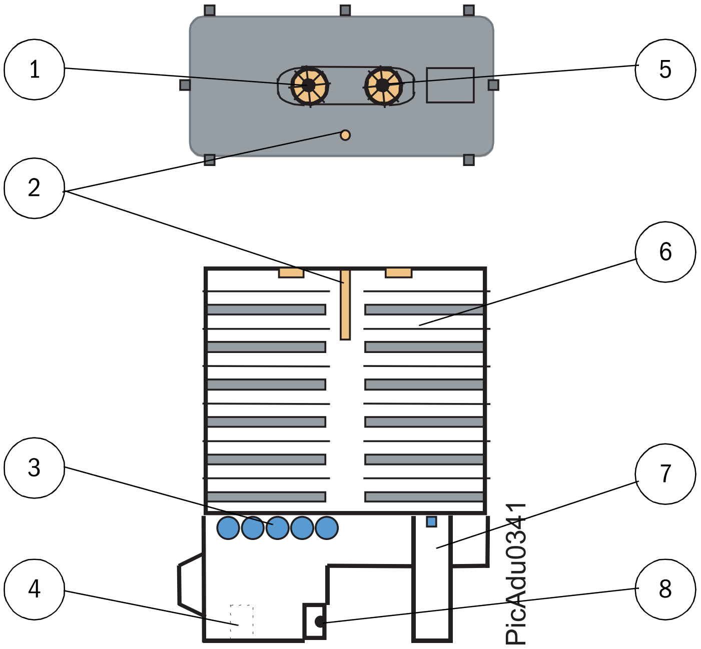


Figure 7 **Parts common to all Aladin Cassettes**

(1) Inflow back valve
(2) Temperature sensor
(3) Cassette ID magnets
(4) Filling system
(5) Outflow back valve
(6) Cross section metal plates & lamellas
(7) Handle
(8) Liquid level window

Different key filling systems

Three different keyed filling systems are used with the Aladin cassettes:

Keyfiller filling system

Used for Halothane A-VHAL, Isoflurane A-VISO, Enflurane A-VENF and Sevoflurane A-VSEV.

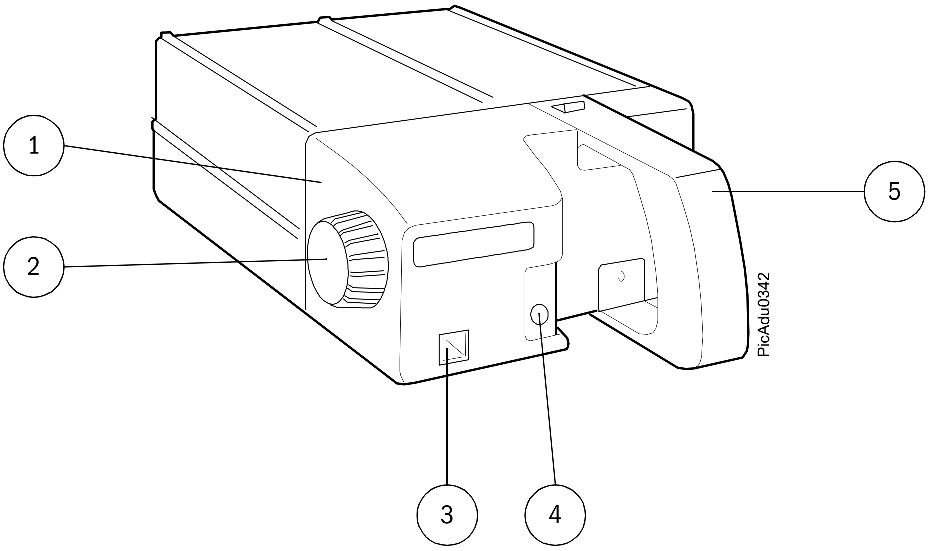


Figure 8 Aladin cassette with keyfiller system

(1) Identification magnets
(2) Filling knob
(3) Keyfiller filling system
(4) Liquid level window
(5) Handle

QuikFil filling system

Used for Sevoflurane A-VSEVQ.

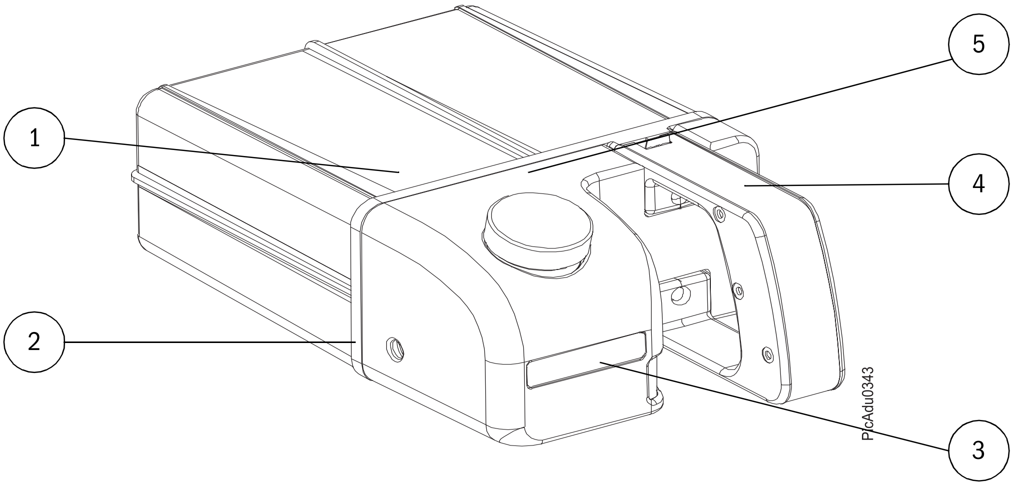


Figure 9 Aladin cassette with QuikFil filling system

(1) Identification magnets
(2) Emptying screw
(3) Liquid level window
(4) Handle
(5) Quik Fil filling system

Desflurane filling system

Used for Desflurane A-VDES. Compatible with Saf-T-Fil bottles.

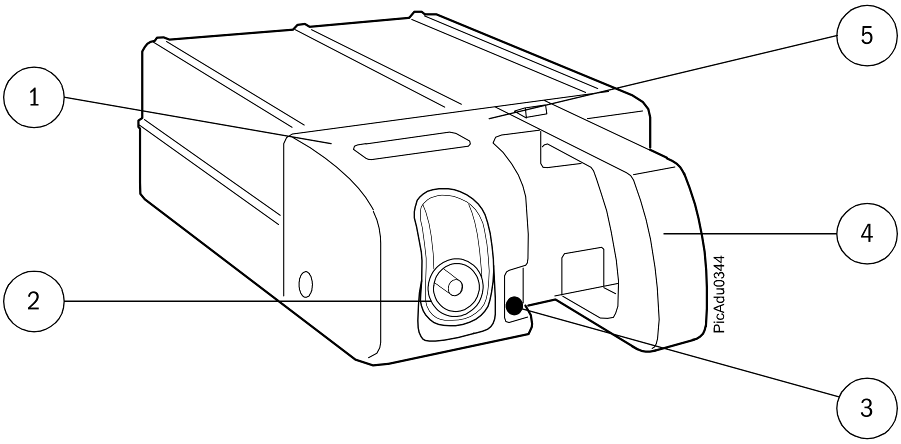


Figure 10 Aladin cassette with Saf-T-Fil system

1. Identification magnets
2. Desflurane filling system
3. Liquid level window
4. Handle
5. Liquid level contacts

The Aladin Desflurane cassette also includes an electronically liquid level measuring device based on the capacitance principle (shown below). The amount of liquid between the metal plates changes the capacitance. The power from the A-FGC1 is transmitted through galvanic and gold plated contacts.

The measured liquid level is displayed as a bar graph on the ADU display.

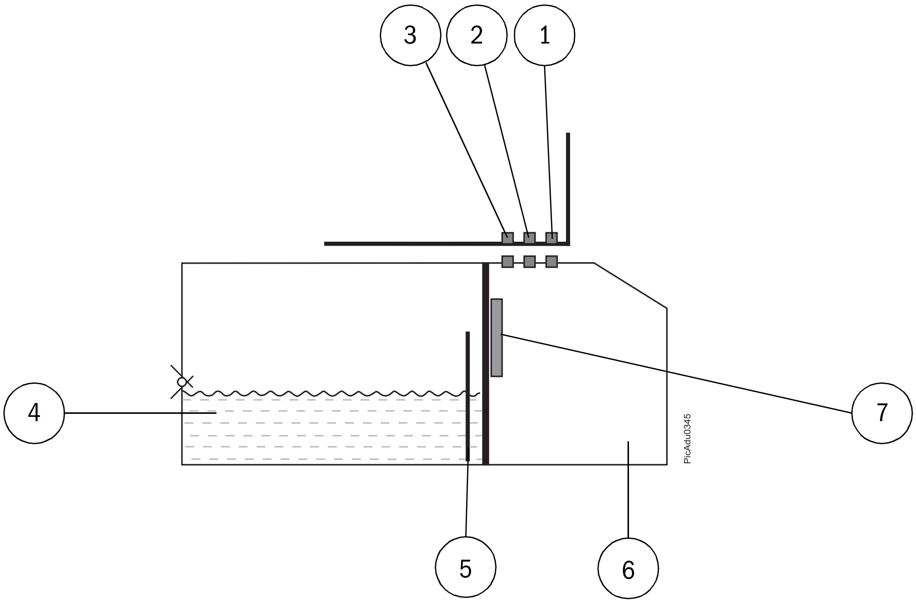


Figure 11 Liquid level measurement principle

(1) Galvanic contacts ground
(2) Galvanic contacts power +12V
(3) Galvanic contacts output 4.4 - 6.6V
(4) Agent liquid
(5) Capacitance plate
(6) Aladin^{TM} desflurane cassette
(7) Sensor board

Overfilling and wrong position prevention

CAUTION All Aladin cassettes should be filled in horizontal position. Do not fill an Aladin cassette when it is connected to the A-FGC1.

To prevent overfilling, all cassettes include an overfilling prevention mechanism that closes the air channel in the Aladin when the liquid level reaches the allowed limit.

If the cassette is tilted about 7 degrees, a safety mechanism prevents filling.

In the Keyfiller system a ball inside the cassette closes the air channel.

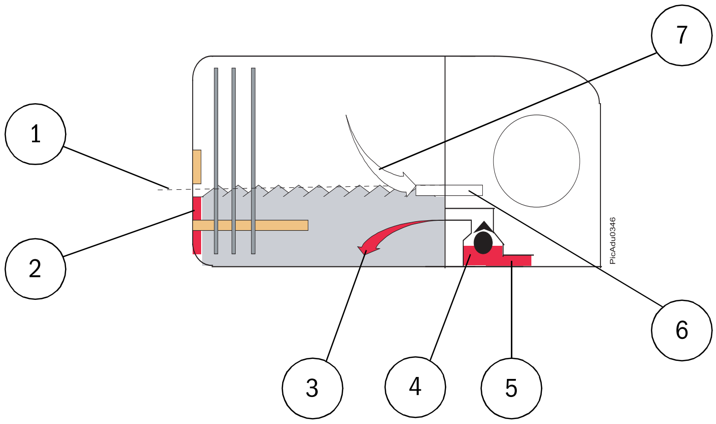
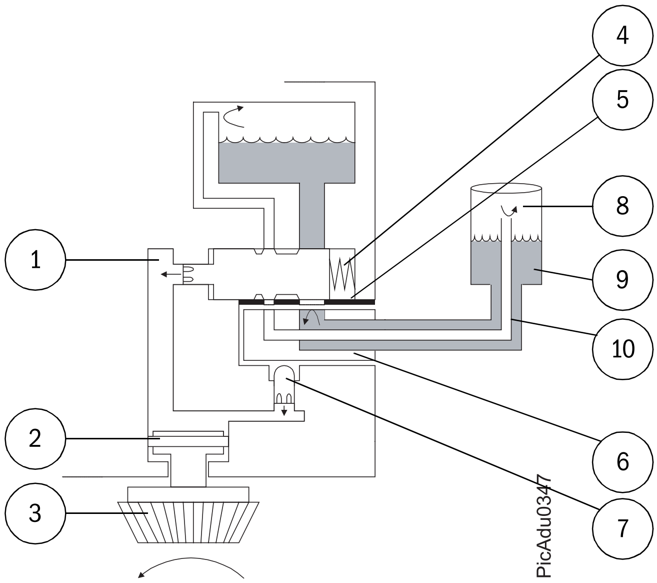


Figure 12 **The keyfiller Aladin cassette principle**

(1) Max. liquid level
(2) Temp. sensor
(3) Liquid flow in
(4) Wrong position valve
(5) Liquid channel
(6) Air channel
(7) Air flow out

The figure below shows the situation before the keyfiller has been locked. The cassette wheel is in open position. The agent and air channels are closed.



(1) Hydraulic oil membrane
(2) Wheel
(3) Cassette lock & fill wheel
(4) Release spring
(5) Filling head membrane
(6) Keyfiller
(7) Locking shaft
(8) Agent bottle
(9) Anesthetic agent liquid channel
(10) Air channel

Figure 13 **The keyfiller system**

In the Quik Fil system there is a spiral inside the cassette guarding against overfilling in normal conditions.

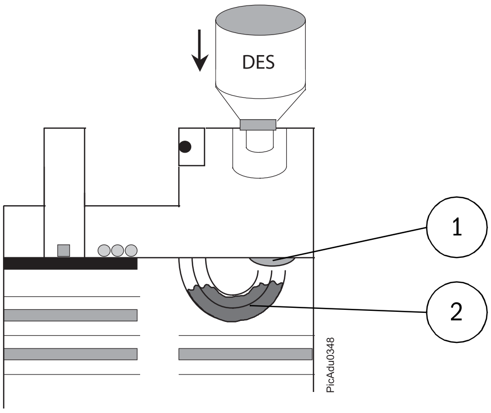


Figure 14 ”Spiral” overfilling guard, wrong position spiral

(1) Bottle press. valve
(2) Wrong position spiral

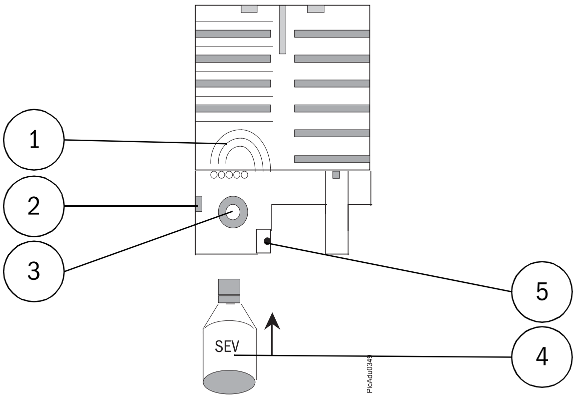


Figure 15 ”Spiral” overfilling guard

(1) Overfilling spiral
(2) Emptying screw
(3) Quik Fil filling system
(4) QuikFil bottle
(5) Liquid level window

The Desflurane cassette which also includes the following safety features:

Filling is prevented if the pressure inside the bottle is > 150 mmHg by an automatic valve that closes the entrance for liquid from the bottle.

If the cassette pressure for some reason should increase to 200-400 kPa, the pressure is released to the filling head (inside mask).

As Desflurane has a low boiling point (22.8° C) the pressure is high at higher temperatures. High pressure inside a bottle or a cassette that is not in use, may therefore occur if the bottle or the cassette has been exposed to temperatures above 26 °C. Before attempting to fill the cassette in such a situation, the temperature difference between the cassette and the bottle must be equalized. (Lower the cassette temperature.)

Fresh Gas Control Unit pneumatic diagram

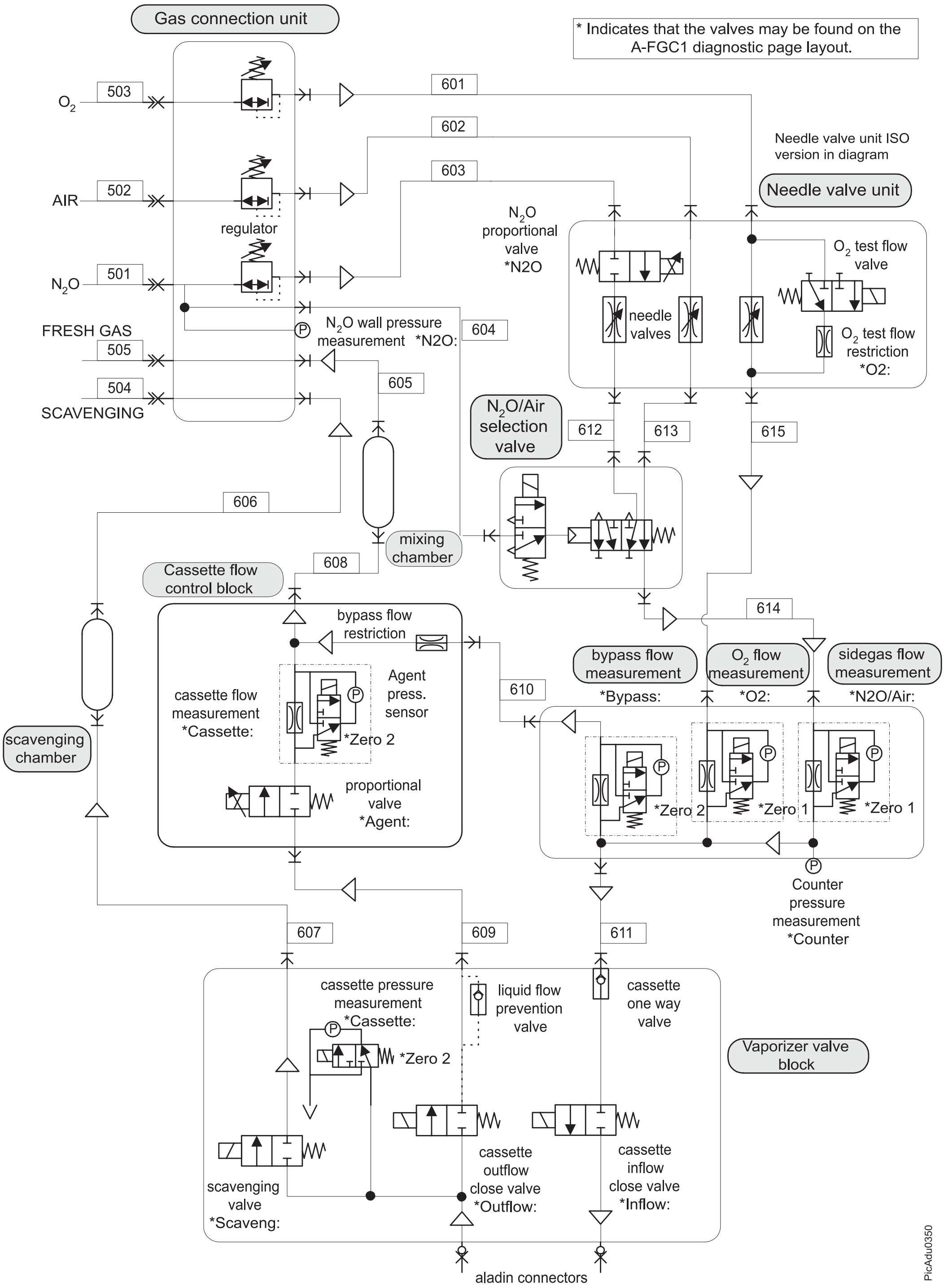

Gas connection unit
* Indicates that the valves may be found on the A-FGC1 diagnostic page layout.
O_2
503
601
602
Needle valve unit ISO version in diagram
AIR
502
603
Needle valve unit
regulator
N_2O proportional valve *N2O
O_2 test flow valve
N_2O
501
needle valves
O_2 test flow restriction *O2:
FRESH GAS
505
N_2O wall pressure measurement *N2O:
604
504
605
SCAVENGING
N_2O/Air selection valve
612
613
615
606
mixing chamber
Cassette flow control block
608
614
bypass flow restriction
bypass flow measurement
O_2 flow measurement
sidegas flow measurement
cassette flow measurement *Cassette:
Agent press. sensor
610
*Bypass:
*O2:
*N2O/Air:
*Zero 2
scavenging chamber
*Zero 2
*Zero 1
*Zero 1
proportional valve *Agent:
Counter pressure measurement *Counter
607
609
611
cassette pressure measurement *Cassette:
liquid flow prevention valve
cassette one way valve
Vaporizer valve block
*Zero 2
scavenging valve *Scaveng:
cassette outflow close valve *Outflow:
cassette inflow close valve *Inflow:
aladin connectors
PicAdu0350

Figure 16 **Fresh Gas Control Unit pneumatic diagram**

Needle valve unit location drawing

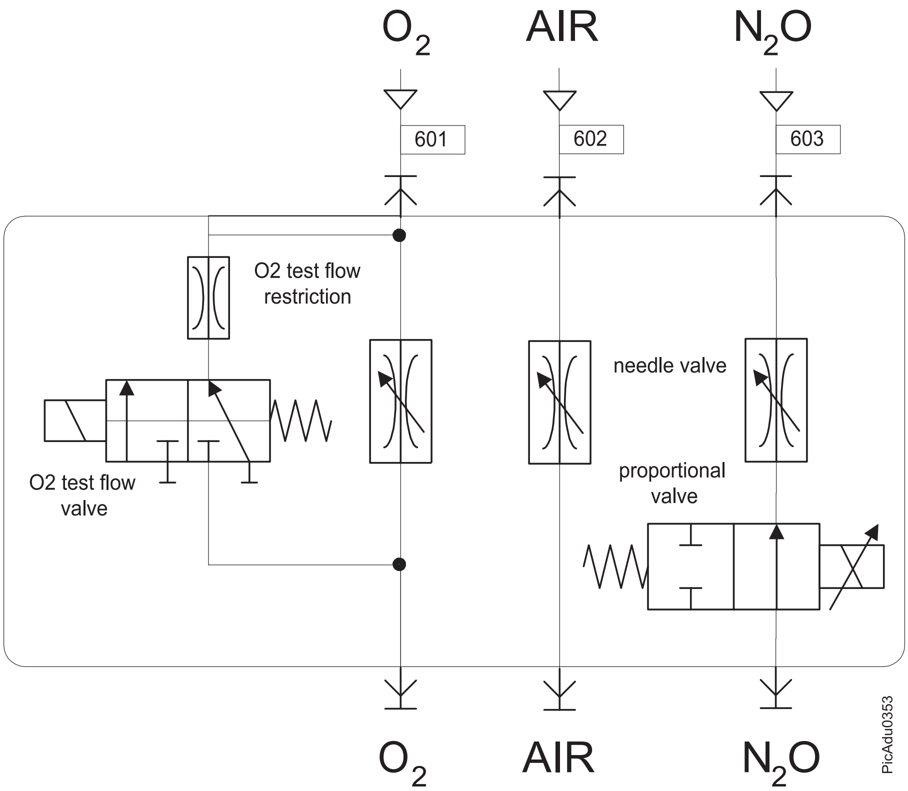

O$_2$
AIR
N$_2$O
601
602
603
O2 test flow restriction
needle valve
O2 test flow valve
proportional valve
O$_2$
AIR
N$_2$O
PicAdu0353

Figure 17 **A-FGC1 needle valve unit, ISO version (Front view)**

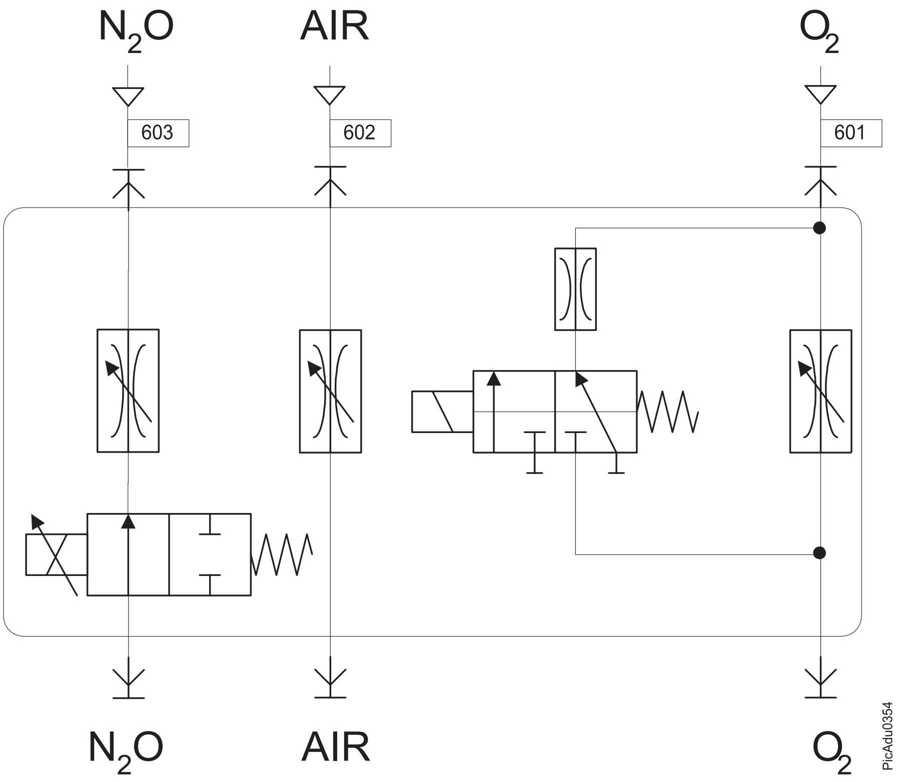

N$_2$O
AIR
O$_2$
603
602
601
N$_2$O
AIR
O$_2$
PicAdu0354

Figure 18 **A-FGC1 needle valve unit, ANSI version (Front view)**

Tubing connection chart A-FGC1 (ISO version)

Tube No.	Tube type	Length (m)	From	To	Gas
601	733482	0.24	O_2 regulator	Needle valve unit	O_2
602	733482	0.24	Air regulator	Needle valve unit	Air
603	733482	0.24	N_2O regulator	Needle valve unit	N_2O
604	733480	0.43	Gas connection unit	N_2O/Air selection valve	N_2O
605	733478	0.23	Mixing chamber	Gas connection unit	Mixed
606	733483	0.13	Scavenging chamber	Gas connection unit	Mixed
607	733483	0.34	Vaporizer valve block	Scavenging chamber	Mixed
608	733478	0.26	Mixing chamber	Cassette flow control block	Mixed
609	733478	0.21	Vaporizer valve block	Cassette flow control block	Mixed
610	733471	0.23	Bypass flow measurement unit	Cassette flow control block	Mixed
611	733480	0.12	Bypass flow measurement unit	Vaporizer valve block	Mixed
612	733472	0.26	Needle valve unit	N_2O/Air selection valve	N_2O
613	733472	0.26	Needle valve unit	N_2O/Air selection valve	Air
614	733472	0.5	N_2O/Air selection valve	Side gas flow measuring unit	N_2O or Air
615	733472	0.62	Needle valve unit	O_2 flow measurement unit	O_2

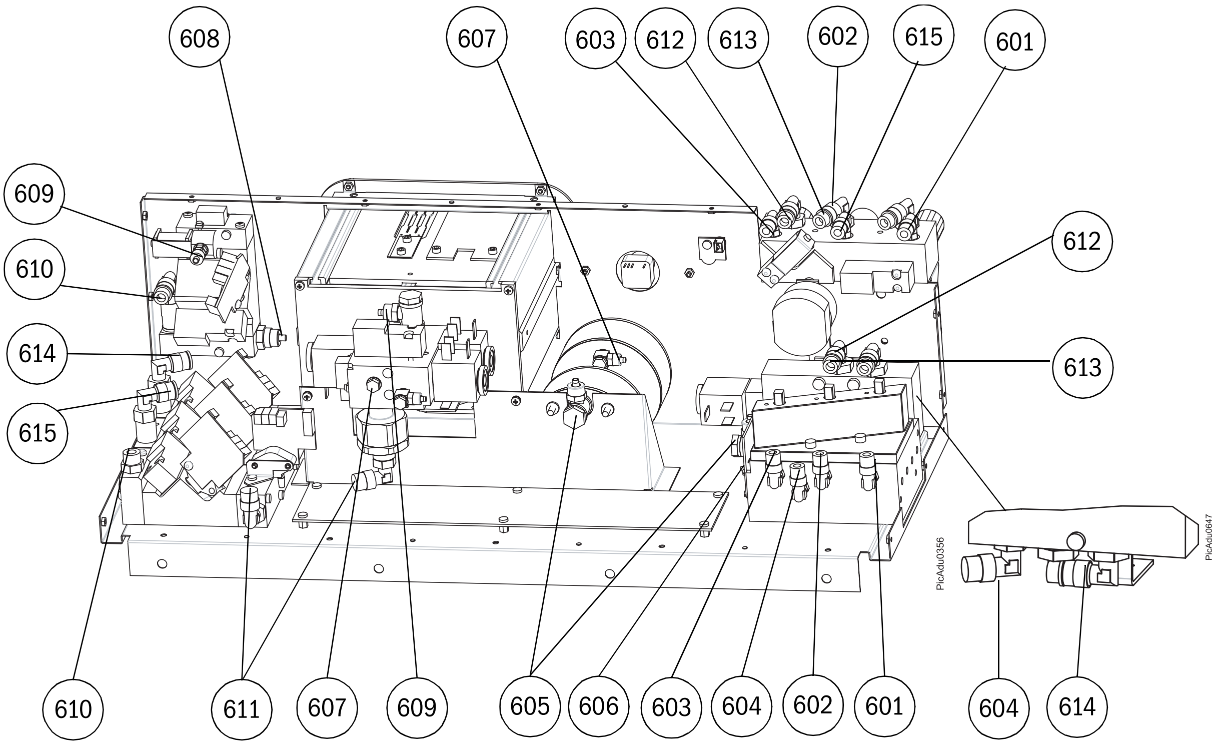


Figure 19 Tubing Position (ISO version)

Tubing connection chart A-FGC1 (ANSI version)

Tube No.	Tube type	Length (m)	From	To	Gas
601	733482	0.24	O_2 regulator	Needle valve unit	O_2
602	733482	0.24	Air regulator	Needle valve unit	Air
603	733482	0.24	N_2O regulator	Needle valve unit	N_2O
604	733480	0.43	Gas connection unit	N_2O/Air selection valve	N_2O
605	733478	0.23	Mixing chamber	Gas connection unit	Mixed
606	733483	0.13	Scavenging chamber	Gas connection unit	Mixed
607	733483	0.34	Vaporizer valve block	Scavenging chamber	Mixed
608	733478	0.26	Mixing chamber	Cassette flow control block	Mixed
609	733478	0.21	Vaporizer valve block	Cassette flow control block	Mixed
610	733471	0.23	Bypass flow measurement unit	Cassette flow control block	Mixed
611	733480	0.12	Bypass flow measurement unit	Vaporizer valve block	Mixed
612	733472	0.26	Needle valve unit	N_2O/Air selection valve	N_2O
613	733472	0.26	Needle valve unit	N_2O/Air selection valve	Air
614	733472	0.5	N_2O/Air selection valve	Side gas flow measuring unit	N_2O or Air
615	733472	0.62	Needle valve unit	O_2 flow measurement unit	O_2

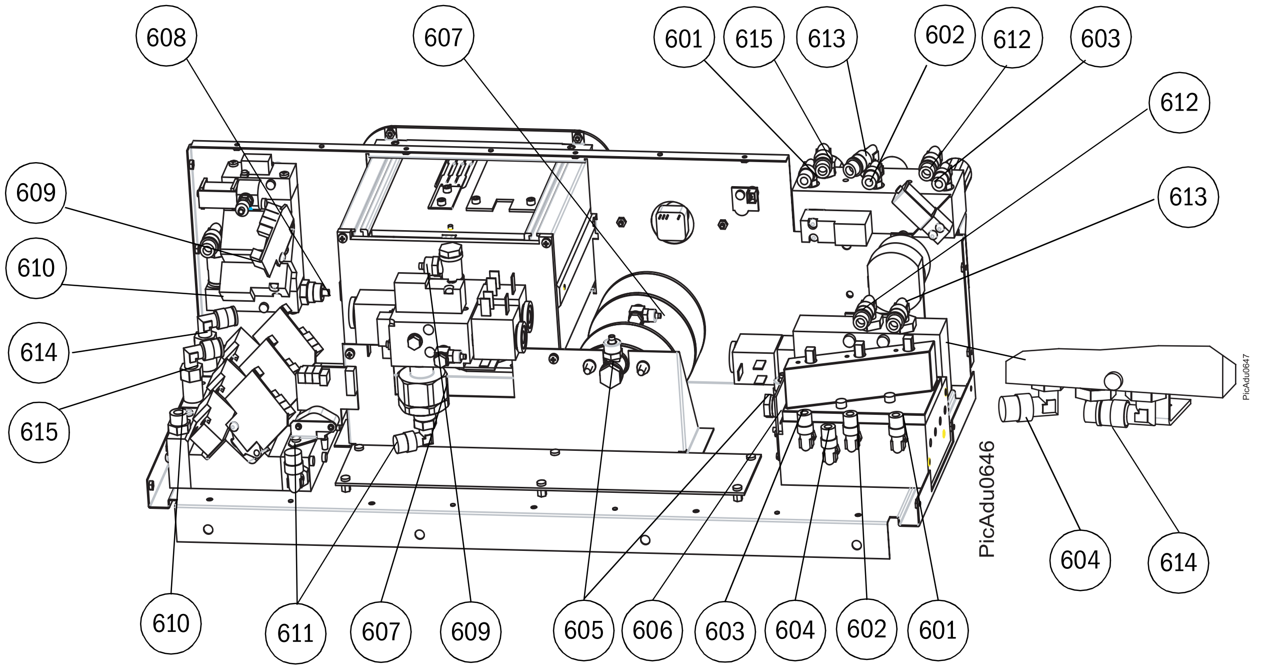


Figure 20 **Tubing position (ANSI version)**

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Location of parts in the Fresh Gas Control Unit

Parts at the front

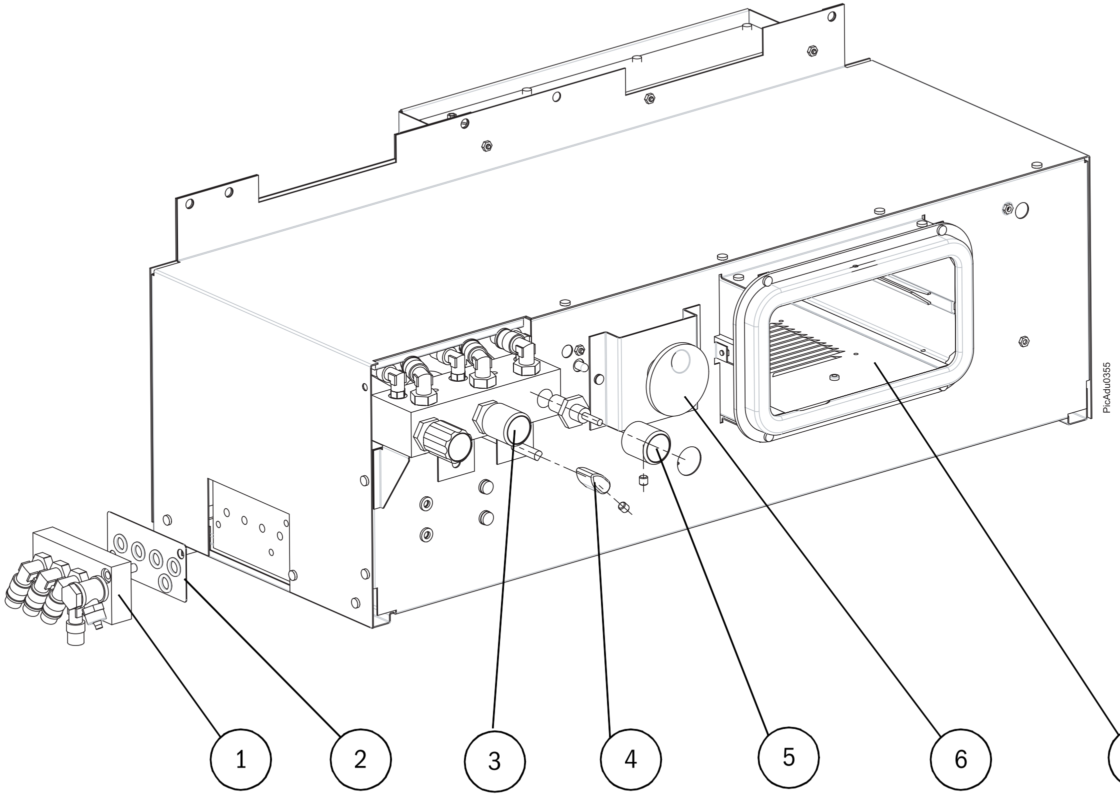
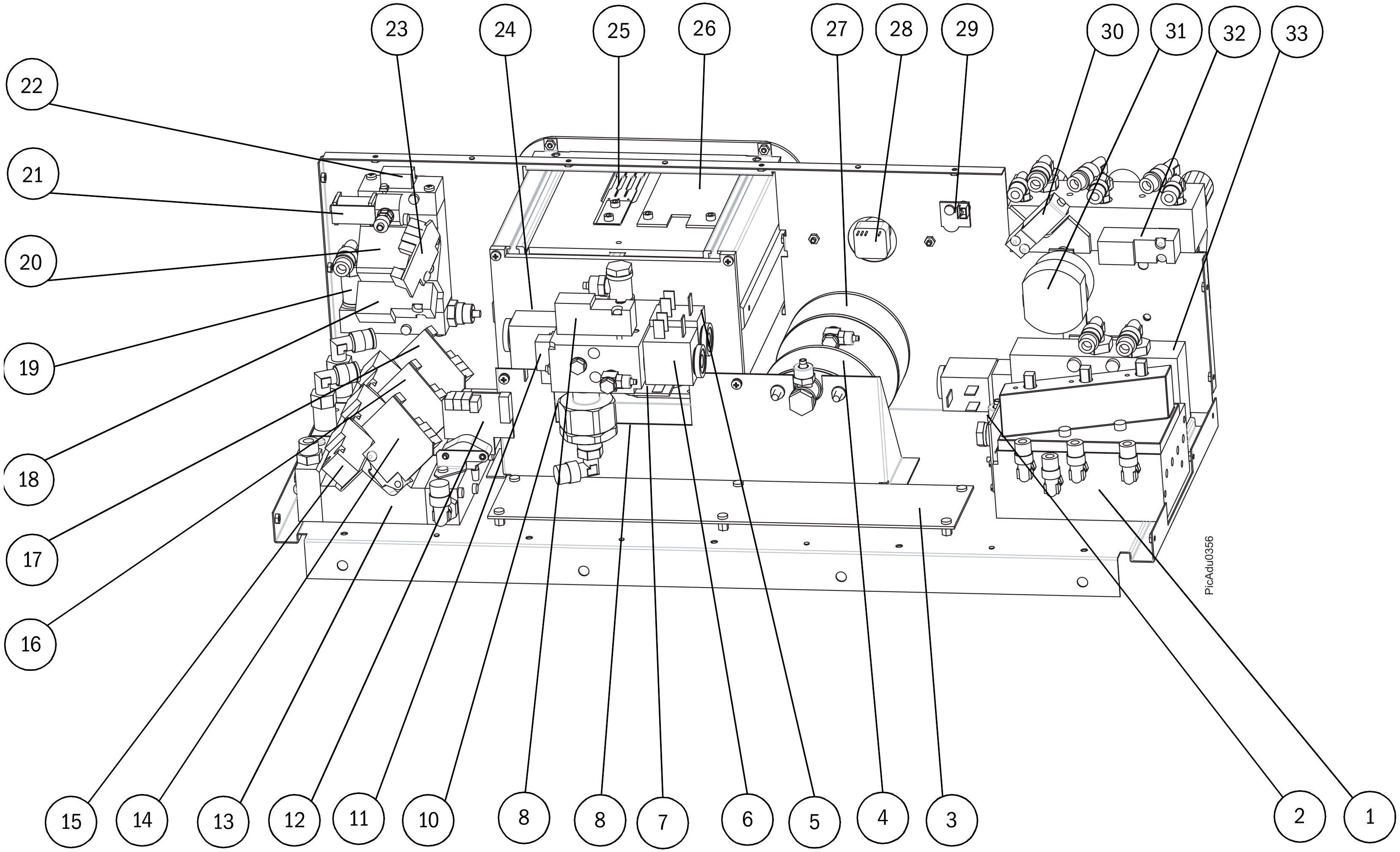

PicAdu0355
1
2
3
4
5
6
7

Figure 21 A-FGC1 front view

Item	Item description
1	A-FGC1 Multiconnector
2	Seal
3	Needle valve unit (ISO and ANSI version)
4	N_2O/Air selector knob
5	Needle valve knobs
6	Agent wheel
7	Cassette housing

A-FGC1 Inside


23
24
25
26
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28
29
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31
32
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18
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13
12
11
10
8
8
7
6
5
4
3
2
1
PicAdu0356

Figure 22 Inside the Fresh Gas Control Unit, rear view

Item	**Part**
1	Gas connection unit (includes regulators)
2	N_2O wall pressure transducer board.
3	Connection board
4	Mixing chamber
5	Cassette outflow close valve
6	Scavenging valve
7	Cassette pressure measurement board
8	Temperature sensor
9	Cassette pressure zeroing valve
10	Cassette one-way valve / O-ring
11	Vaporizer Heating resistor
12	Counter pressure measurement board
13	Flow measurement units from front (a) Bypass. (b) O_2 (C) Sidegas
13a	Bypass gas flow measurement unit
13b	O_2 gas flow measurement unit
13c	Side gas flow measurement
14	Bypass pressure measurement board
15	Zeroing valve (1W) 13 a, b and c
16	O_2 pressure measuring board
17	Side gas pressure measuring board
18	Zeroing valve
19	Bypass flow restrictor
20	Cassette flow measuring unit
21	Agent proportional valve
22	Agent heating resistor
23	Cassette flow measuring board
24	Cassette inflow close valve
25	Agent Liquid level board
26	Cassette identification board
27	Scavenging chamber
28	Agent control wheel
29	Agent led board
30	N_2O proportional valve
31	N_2O/Air selection switch
32	O_2 Test valve
33	N_2O/Air valve (ISO version shown)
-	Fan (located underneath the cassette housing

Electronics in the Fresh Gas Control Unit

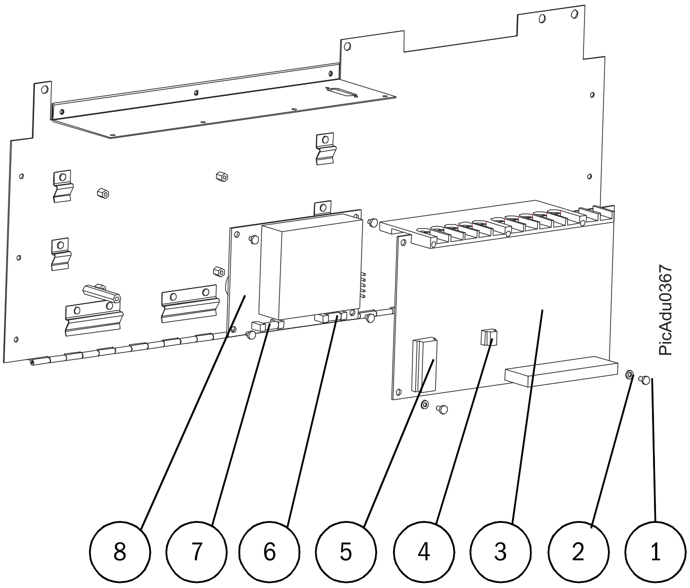

Figure 23 Electronics in the Fresh Gas Control Unit

Item	Part
1	Screw
2	Washer
3	A-FGC1 CPU board
4	EEPROM memory (D7)
5	A-FGC1 Software
6	Fuse F2 630 mA
7	Fuse F1 2.5A
8	DC/DC power board

Fresh Gas Control Unit electronics

Sensors and electromechanical components are located inside the unit. The DC/DC power board, and CPU board are concealed behind the unit.

The components and CPU board are connected to each other via a connection board and a cable. The sensors have their own amplifier boards and the valves are connected directly to the connectors and the board. A single cable connects the units to the CPU board.

All the electronic components are Electromagnetic Interference (EMI) protected inside a shielded frame.

Data on gas flows, cassette pressure, cassette identification, agent wheel position, agent level (desflurane), agent temperature, N_20/Air selector and some alarms are sent to the delivery unit central electronics.

The CPU board is concealed behind the unit, consists of the power/current limiting circuits. Components inside the unit is power limited to below 10 VA because of safety requirements. All power limited driving signals are directed via flat cable from the CPU board to the connection board.

DC/DC power board

The DC/DC power board, generates supply voltages for the CPU board and for the pressure sensor boards; +5 V for digital circuits and ±15 V for analogue circuits.

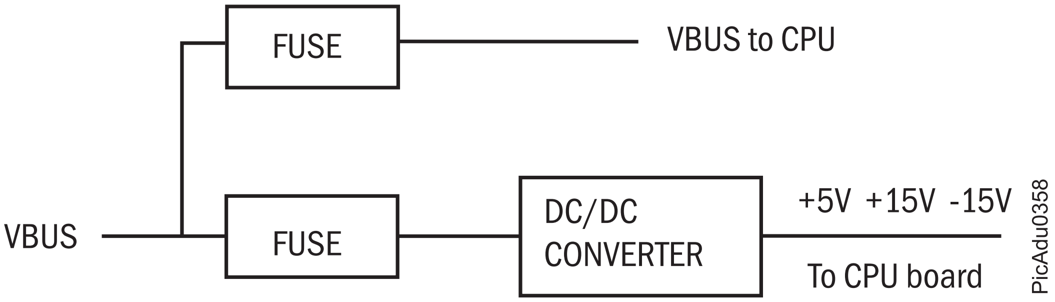

Figure 24 **DC/DC Power Board**

CPU Board

The CPU controls the functions of the ADU Fresh Gas Controller. It measures the fresh gas flows and sends the data to the main CPU through the serial interface. It also controls the level of anaesthetic agent in the fresh gas flow.

The processor is a DS80C320, an Intel 51-derivative circuit accompanied by external RAM for runtime data, external EPROM for software storage and a serial EEPROM for calibration data.

The reset circuit includes power-up reset, supply voltage monitoring and watchdog circuit. The reset signal always causes the outputs to go into off state.

Valve drivers

There are two kind of valve driver outputs, proportional and on/off -type. In the proportional valve driver, the current setting is analogous, so that the current may be set anywhere between zero and max. setting.

The on/off valve drivers, are MOS-FET types, where the load is connected between the output and the ground.

All valve driver circuits have current limit circuits on the supply side. The product of the short-circuit current and supply voltage is limited to below 10 VA, so in case of output short to ground, there is no possibility of sparks and subsequent fire.

Reset causes the outputs to go into off state. On proportional valve drivers this is performed by disabling the positive supply side on the current limit circuit. This means that the cassette valves will be closed and sidegas selection valve is set into Air position. Thus no agent or N_2O is delivered.

Digital inputs

The digital inputs consists of five cassette ID lines, two sidegas selection lines and two agent control wheel input lines. All of the inputs have internal pull-up resistors and they are connected to open collector type outputs or mechanical switches that connect the lines to ground. The agent control wheel inputs also have Schmitt trigger circuits to adjust the signals suitable for the hardware decoder.

Analogue inputs

For analogue inputs there is a 16-bit A/D-converter on the board. Two eight-channel analogue multiplexers are required to select and measure all the input voltage channels. In addition to the pressure, flow, temperature and liquid level signals (only on the desflurane cassette), the supply voltages are also measured for self diagnostics.

The input voltage range of the analogue channels of the board, is 0 to 10V. It is divided by two in a resistor network to convert it to the input voltage range of the A/D-converter. The A/D-converter uses +5 Vref reference voltage that is also employed in generating the +10V supply for the pressure sensors.
As an exception to the previous, the temperature sensor inputs are connected directly to the sensors; 50 Kohm NTC-resistors. The two amplifiers on the board convert the temperature signals suitable for the A/D-converter input voltage range.

Voltage supply

The CPU board requires several supply voltages:

- +5V for the digital electronics, min. +4.75V max +5.25V
- +15V and -15V for the analogue electronics,
  +15V: min. +14V max +17V
  -15V: min. -17V max -14V
- VBUS for the valve power supplies.

The VBUS voltage is not used directly for driving the valves, there is +12V (min. +12.7V max 13.8V) switching regulator on the board, supplying power to the valve drivers.

Hardware watchdog

The hardware watchdog resets the software and forces the hardware into a safe state in case of a software failure.

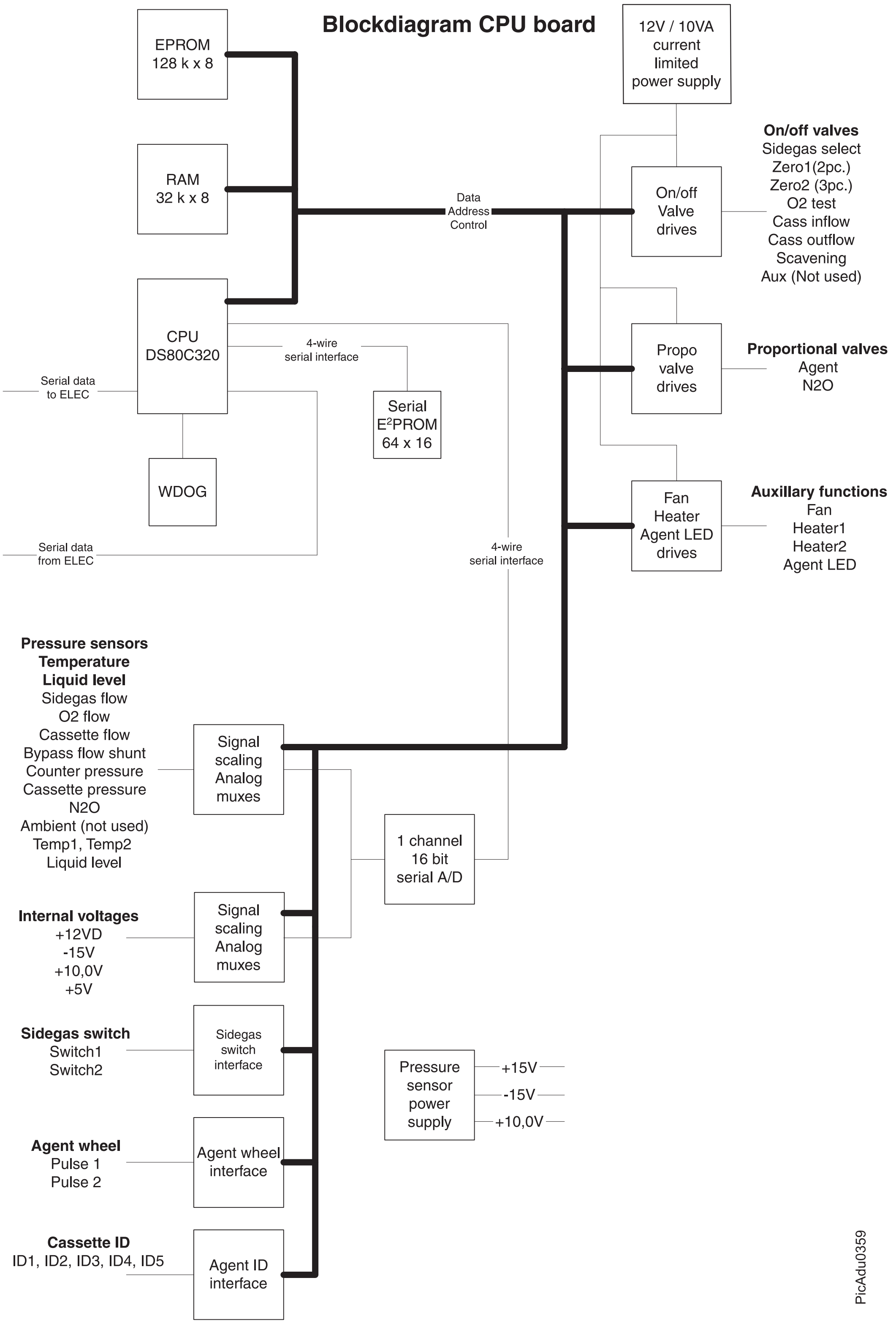
Blockdiagram CPU board
EPROM 128 k x 8
RAM 32 k x 8
CPU DS80C320
WDOG
Serial data to ELEC
Serial data from ELEC
4-wire serial interface
Serial E²PROM 64 x 16
Data Address Control
4-wire serial interface
12V / 10VA current limited power supply
On/off Valve drives
On/off valves
Sidegas select
Zero1(2pc.)
Zero2 (3pc.)
O2 test
Cass inflow
Cass outflow
Scavening
Aux (Not used)
Propo valve drives
Proportional valves
Agent
N2O
Fan Heater Agent LED drives
Auxillary functions
Fan
Heater1
Heater2
Agent LED
Pressure sensors
Temperature
Liquid level
Sidegas flow
O2 flow
Cassette flow
Bypass flow shunt
Counter pressure
Cassette pressure
N2O
Ambient (not used)
Temp1, Temp2
Liquid level
Signal scaling Analog muxes
1 channel 16 bit serial A/D
Internal voltages
+12VD
-15V
+10,0V
+5V
Signal scaling Analog muxes
Sidegas switch
Switch1
Switch2
Sidegas switch interface
Pressure sensor power supply
+15V
-15V
+10,0V
Agent wheel
Pulse 1
Pulse 2
Agent wheel interface
Cassette ID
ID1, ID2, ID3, ID4, ID5
Agent ID interface
PicAdu0359

Figure 25 CPU Board block diagram

Connection board

The connection board of the fresh gas control unit serve signal lines and connectors for the electropneumatical components outside the gas tight box.

The connection board is connected to the CPU board via a ribbon cable. It is always important to check that the cable sealing is tight between the electronics box and the inside of the module.

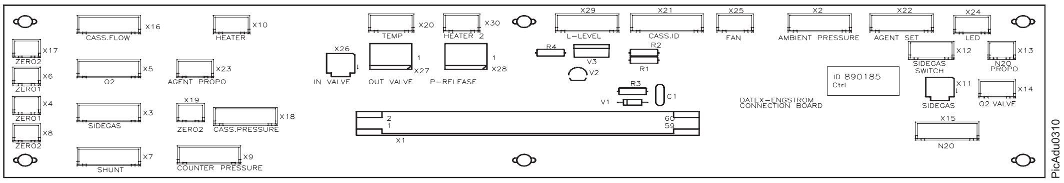
X16
CASS.FLOW
X10
HEATER
X20
TEMP
X30
HEATER 2
X29
L–LEVEL
X21
CASS.ID
X25
FAN
X2
AMBIENT PRESSURE
X22
AGENT SET
X24
LED
X17
ZERO2
X6
ZERO1
X4
ZERO1
X8
ZERO2
X5
O2
X23
AGENT PROPO
X26
IN VALVE
1
X27
OUT VALVE
1
X28
P–RELEASE
R4
V3
V2
R2
R1
R3
V1
C1
X12
SIDEGAS SWITCH
X13
N2O PROPO
ID 890185
Ctrl
X11
SIDEGAS
X14
O2 VALVE
X3
SIDEGAS
X19
ZERO2
X18
CASS.PRESSURE
2
1
X1
60
59
DATEX–ENGSTROM
CONNECTION BOARD
X15
N2O
X7
SHUNT
X9
COUNTER PRESSURE
PicAdu0310

Figure 26 A-FGC1 connection board component layout

REPAIR INSTRUCTIONS A-FGC1

General

The repair instructions in this manual are limited to a few basic items. Detailed repair and installation instructions are generally included in the packages of the spare parts. Repairs do not only mean replacement of parts/units, but also some service and miscellaneous information.

After repair or replacement of the A-FGC1 a A-FGC1 related Functional check must be performed. This shall include the high pressure test, see chapter 5 *"Maintenance"* for detailed description.

After any service of the Aladin cassette the System checkout must be performed.

NOTE: For best accuracy during calibration and checks when measuring gas flows up to 5 l/min. it is recommended to use tubings and connectors with an inner diameter of at least 3.5 mm. For flows above 5 l/min. the inner diameter of tubing and connectors shall be greater that 4 mm.

Removing the Fresh Gas Control Unit from the ADU

Tools:	*Flat blade screwdrivers* *Cross-head screwdrivers* *2.5 and 4 mm Allen wrench* *Wrench*
Spare parts:	*Fresh Gas Control Unit (A-FGC1)*

1. Disconnect the pipeline gases and close cylinder valves.
2. Turn the N_2O/Air selector switch into N_2O position and release N_2O and Air pressures by first opening the N_2O flow fully and then opening O_2 flow to 1 l/min.
3. Turn the N_2O/Air selector switch to Air position and release air pressure by opening the Air flow control.
4. Disconnect the pipe line gas hoses from the ADU Wall Gas Unit.
5. Turn the ADU off and disconnect the power plug from the wall socket.
6. Remove the rear plastic cover (10 Allen screws including toothed washers).
7. Disconnect the A-FGC1 multiconnector (Two Allen screws) and the seal behind it.
8. Remove the needle valve knobs and N_2O/Air switch knob from the front panel.
9. Remove the two Allen screws holding the gas inlet assembly and lower it down.
10. Remove the lower left side panel located under the Bellows Block. (Two Allen screws including the toothed washers).
11. Remove the remaining seven Allen screws holding the Fresh Gas Control unit to the ADU frame.
12. Pull the Fresh Gas unit half way out and remove the VBUS cable connector (Two screws) from the A-FGC1.
13. Take out the Fresh Gas Control unit from the Frame.

Reassembling the Fresh Gas Control Unit to the ADU.

Reassembling is essentially the reversed process of what was described in the previous paragraph.

CAUTION When pushing the fresh gas control unit in along the rails. Watch that the axes of the needle valve knobs will go through the holes of the front panel.

CAUTION Make sure that the A-FGC1 multiconnector is placed correctly before retighten the Allen screws.

CAUTION Make sure that flow controls knobs are replaced on their original places.

Servicing Aladin Cassettes

NOTE: For filling of all types of Aladin cassettes, see the ADU *"User's Reference Manual"*.

NOTE: Before service or returning a cassette to the manufacturer - make sure that the cassette is empty.

Cassettes with Keyfiller filling system

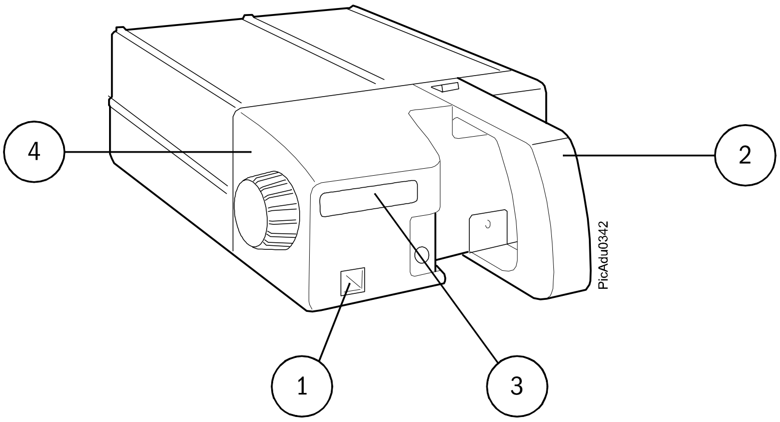

Figure 27 Cassette with keyfiller filling system

Field serviceable parts of the Aladin cassette are:

1. Filling head gasket
2. Cassette handle
3. Cassette labels
4. Mask

The Keyfiller filling system is based on high hydraulic pressure system requiring always manufacturers production equipment for repair. See the spare part list for more details.

Filling and emptying a Aladin Cassette with Keyfiller system

For filling please see the "*User´s Reference Manual".*

For draining a Keyfiller Aladin cassette use the same procedure as when filling, but turn the Aladin cassette so that agent flows into an empty agent bottle and wait until the cassette is totally drained.

Installation of Aladin Keyfiller gasket

1. Remove the 4 Pozidriv screws holding the plate as picture below shows.
2. Remove the old gasket
3. install the new gasket with frame as picture shows.
4. Reinstall the plate
5. Insert a Keyfiller and check that the Aladin cassette both can be filled and emptied

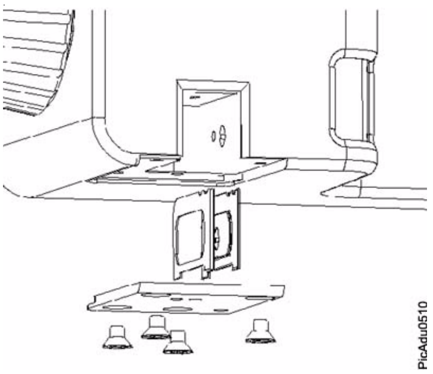

Figure 28 Installation of Aladin Keyfiller gasket

Cassettes with Quik Fil filling system

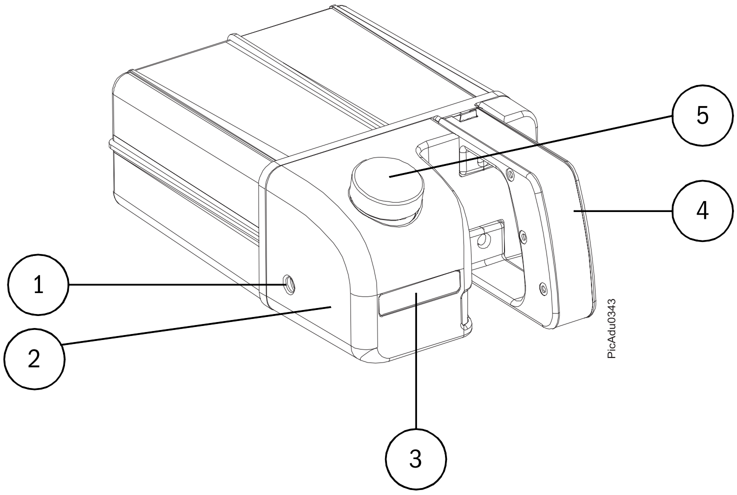

Figure 29 Cassette with Quik Fil filling system

Field serviceable parts of the Aladin cassette are:

1. Emptying screw
2. Mask
3. Cassette labels
4. Handle
5. Quik Fil filling system. (See the spare part list and exploded views for details).

Emptying a cassette with Quik Fil filling system

1. Remove the plug covering the emptying screw.
2. Open the emptying screw 2 or 3 turns (6 mm Allen key). Do not remove completely.
3. Connect an empty Quik Fil bottle to the filling system and hold it tight.
4. Turn the Aladin cassette so that agent flows into the bottle and wait until the cassette is empty.

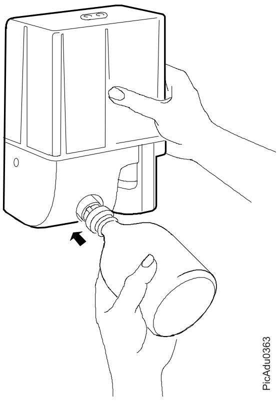

Figure 30 **Emptying the cassette**

5. Remove the bottle.
6. Close the emptying screw and fasten the cover plug.

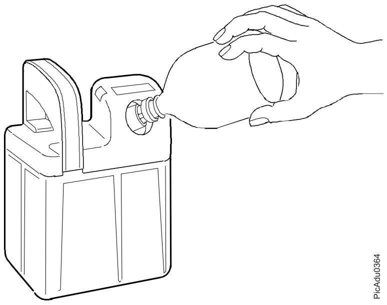

Figure 31 **Checking wrong position filling prevention**

7. Check that the overfill protection mechanism works. It does not work if the air channel is open to room air, for example if the emptying screw is open.
8. Turn the cassette and check that the cassette cannot be filled in a wrong position. The flow of air bubbles should stop within a few seconds, and the liquid should stay in the bottle.

Cassettes with desflurane filling system

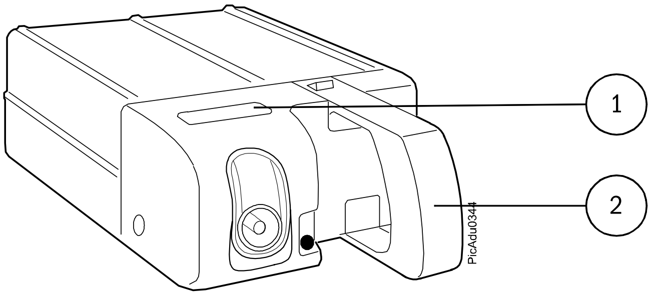

Figure 32 **Cassette with desflurane filling system**

The field serviceable parts of the Aladin cassette are:

1. Cassette label
2. Handle

Emptying a cassette with desflurane filling system

1. Open the emptying screw (1) two to three turns
2. Connect an empty bottle to the filling connector
3. Let the agent drain completely into the bottle
4. Close the emptying screw (1)

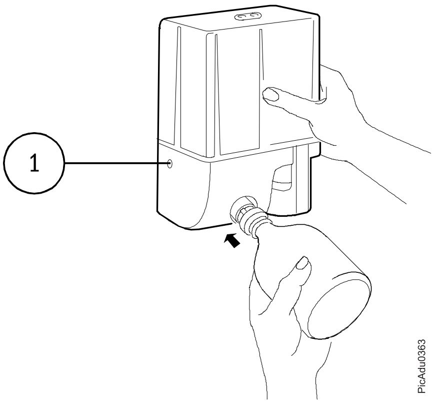

Figure 33 Emptying a cassette with desflurane filling system

5. Check that the overfill protection works by first turning the cassette and bottle upright
6. Push the bottle against the cassette
7. If no air bubbles appear in the bottle, the overfill protection works well

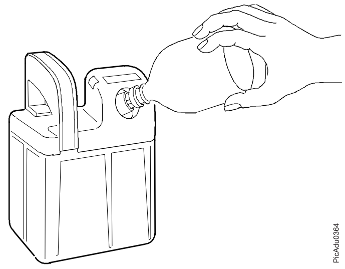

Figure 34 Checking wrong position filling prevention

Replacement of the EEPROM memory and the A-FGC1 software

In case of a CPU board (see 3 below) failure; transfer the EEPROM memory D7 (4) or software (5) from the old CPU board to new CPU board. There is no need for recalibration. If however, a new EEPROM is installed, all calibrations of the unit must be performed.

The EEPROM memory contains the module serial numbers and calibration data.

When ordering an EEPROM circuit as a spare part, the serial number of the unit where it should be installed in must be stated.

If the software or the EEPROM is replaced, carry out a Functional check.

To replace the EEPROM (4) or software (5) proceed as follows:

1. Mains or gas supplies must not be connected to the unit.
2. Remove the rear plastic cover of the ADU and metal cover over the A-FGC1.
3. Replace the EEPROM or software and refit the covers.
4. Reconnect pipeline gas and mains supplies.

NOTE: After installation of a new EEPROM the A-FGC1 must be calibrated.

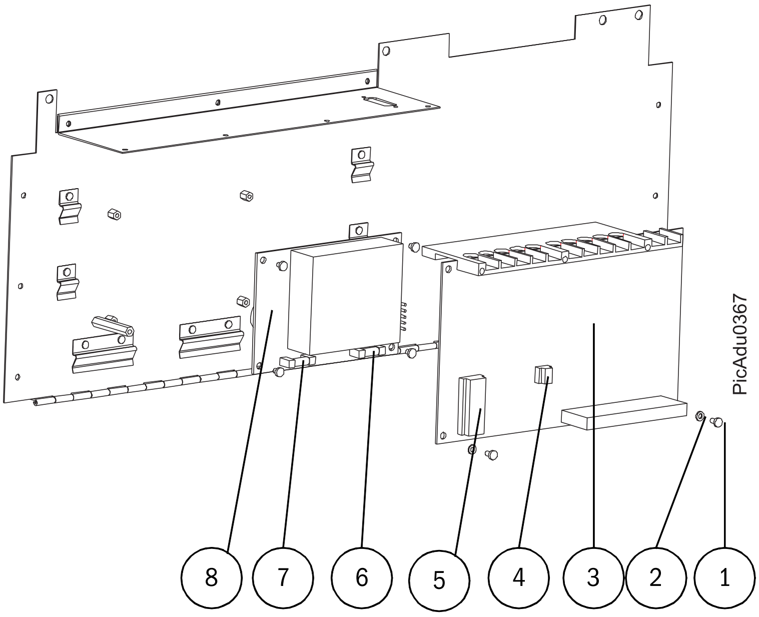

Figure 35 Exploded view of the A-FGC1 electronics

Replacement of fuses on the DC/DC power board

To replace the Fuse on DC/DC power board (8 in fig below) proceed as follows:

1. No mains or pipeline gases connected to the unit.
2. Remove the rear plastic cover of ADU and metal cover of the A-FGC1.
3. Replace the faulty Fuse F1 or F2. Item (6) F2 = 630 mA and item (7) F1 = 2.5A.
4. Refit covers.
5. Reconnect inlet gases and mains.

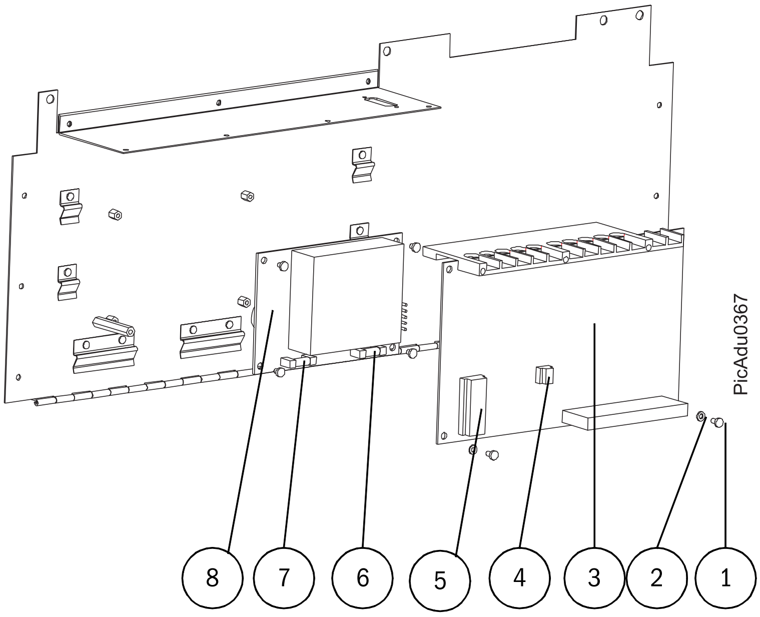

Figure 36 Exploded view of the A-FGC1 electronics

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CALIBRATION A-FGC1

General reqiurements

- The measuring equipment should be accurate and calibrated.
- There are many types of flow and pressure test devices available that can be used to complete this procedure. Datex-Ohmeda recommends no specific device. Specifications are provided with this chapter. The flow and pressure test devices shall have an accuracy of +/-2,5% or better.
- Datex-Ohmeda assumes that technical and biomedical professionals know how to use the device available at his/her institution. Therefore, test device instructions are not included here.
- If a check do not pass a test, verify and make sure that your test devices and its setup to the measuring point are correctly done before starting to calibrate or changing parts.
- Before flow calibration, ambient pressure on ADU shall be set on the average level of the region. Also Man. and Auto leak checks should be done.
- The ADU is calibrated in ATP (ambient temperature and pressure).
- Always makes sure to understand the function of the test devices before calibration.
- Always remembers to not have any measuring tubes connected to the test device when you Zeroing it.
- The calibration procedure must follow the order as specified in calibration tree below.

NOTE: The calibration procedure must follow the order (horizontally) specified in the calibration tree below

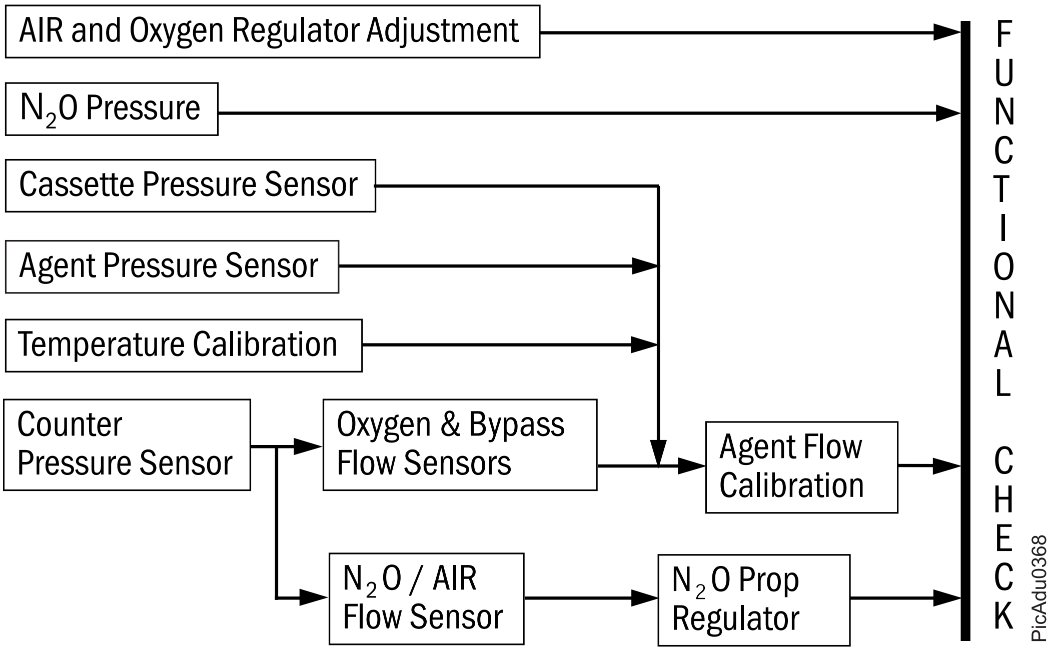

AIR and Oxygen Regulator Adjustment
N_2O Pressure
Cassette Pressure Sensor
Agent Pressure Sensor
Temperature Calibration
Counter Pressure Sensor
Oxygen & Bypass Flow Sensors
Agent Flow Calibration
N_2O / AIR Flow Sensor
N_2O Prop Regulator
FUNCTIONAL CHECK
PicAdu0368

Figure 37 **Calibration tree for the Fresh Gas Control Unit**

Adjustment of the air and O_2 pressure regulators

The procedure for adjusting (checking) O_2 and air regulators are identical to the obvious exception of the gas selected for the flow control and test device.

Equipment needed:	*Flow/pressure test device*
	Pozidriv cross-head screwdriver
	Wrench
	Allen wrench
Settings:	*ADU Off*
	Pipeline gases connected
	No gas flows
	N_2O/Air selector in Air position

1. Check that the inlet pressures for Air/O_2 are within the 2.7 - 8 bar range (39.7-117.6 PSI) (See pressure gauges).
2. Connect the test device high flow inlet to the fresh gas outlet with a hose. Set the test device to appropriate Air or O_2 range. The reading on the test device should be 0.0. Zero.

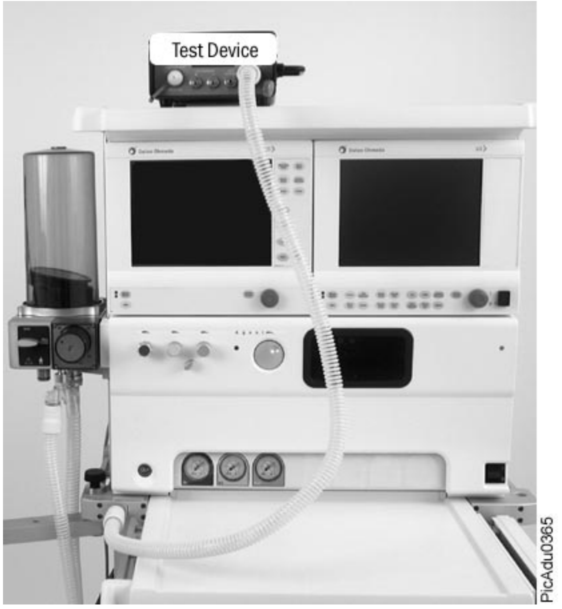


Figure 38 Adjustment of the O_2 and air pressure regulators

3. Open fully the flow control in question. The Test Device should show 14 l/min. ± 0.5. If it need to be adjust proceed with step 4.
4. Remove the rear plastic cover (10 Allen screws), fold down the gas inlet part on the A-WGU (2 Allen screws) and open the rear cover of the fresh gas control unit (9 Pozidriv screws).
5. Adjust the relevant regulator to the test device shows 14 l/min.

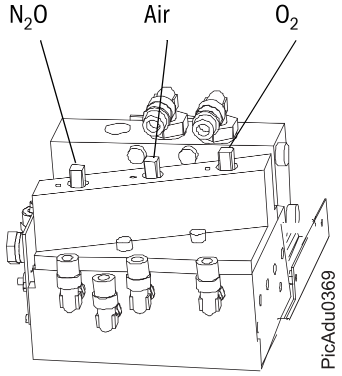


Figure 39 A-FGC1 Pressure regulators

6. Disconnect the relevant gas inlet from the central outlet and let the gas leave the system completely by opening the relevant flow control.
7. Close the flows and reconnect the gas inlet to the central outlet and recheck that the flow indicated by the Test Device is 14 ± 0.5 l/min.
8. Proceed with next gas (step 1).
9. Refit covers and perform the needed calibrations according to the calibration tree.

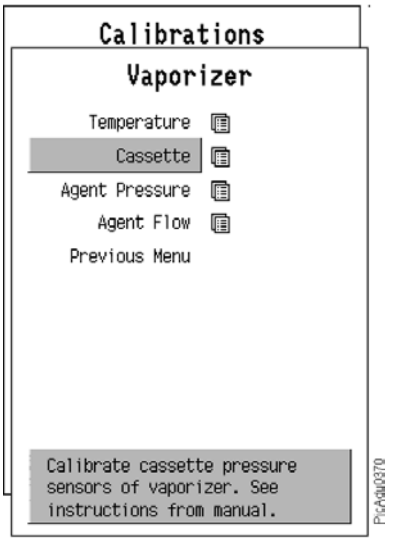
Vaporizer calibration

Cassette pressure sensor calibration

This calibration calibrates the gain of the cassette pressure sensor. The calculation is linear and the calibration factor is stored in EEPROM 52. The zero point of this sensor is calibrated frequently during normal operation.

Equipment needed:	*Flow/pressure test device* *”Cuff” pump* *Cassette pressure calibration adapter*
Settings:	*ADU On* *Pipeline gases connected* *Manual mode* *No gas flow*

1. Enter test device high pressure range mode (mmHg).
2. Zero the test device. The reading on the test device should be 0.0.
3. Push the **Setup** key, Enter ***Service*** and enter the calibration password. Select ***Calibration - Vaporizer - Cassette***.


Calibrations
Vaporizer
Temperature
Cassette
Agent Pressure
Agent Flow
Previous Menu
PicAdu0370

Calibrate cassette pressure sensors of vaporizer. See instructions from manual.

Figure 40 **The vaporizer cassette calibration menu**

4. Connect test equipment as shown below

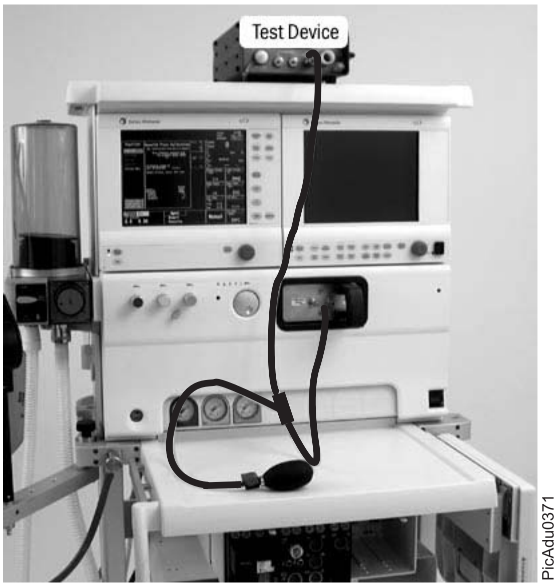

Test Device
PicAdu0371

Figure 41 **Vaporizer cassette calibration arrangement**

5. Start calibrating by selecting ***Start CAL -Give Pressure***.
6. Create the reference pressure by ”pumping up” the pressure until the Test Device indicates 500 - 750 mmHg.

NOTE: Beware that during these procedures automatically zeroing are performed (about every 15 second.) of the cassette sensor which will cause the pressure drop and this is not a fault.

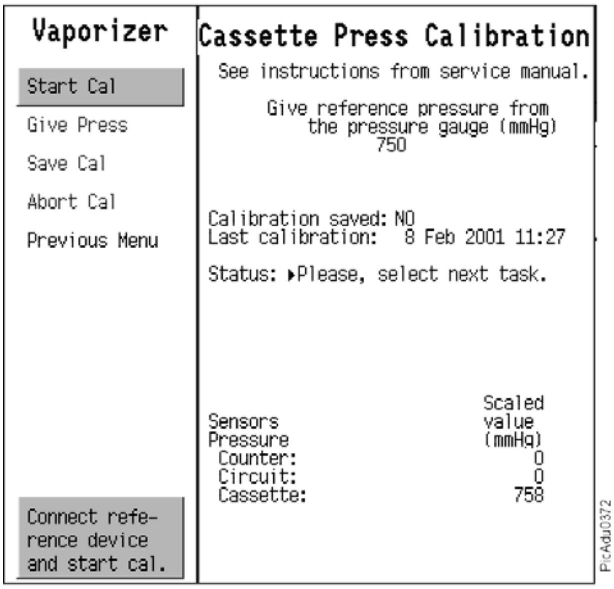
7. Enter reference pressure by turning **Comwheel**. Push **Comwheel** when entered pressure corresponds to the Test Device pressure.
8. When status ‘Calibration OK’ is displayed, the calibration may be saved by ***Save CAL*** or aborted by selecting ***Abort CAL***. If the status is ‘Calibration Failed’, abort the calibration by selecting ***Abort CAL***.
9. Select ***Previous menu***. Perform the needed calibrations according to the Calibration Tree.

Agent pressure sensor calibration

This calibration calibrates the factors used in the calculation for compensating the zero signal change caused by the static pressure and the magnetic effects of the valves in the vaporizer valve block. The calculation is linear and the calibration factors are stored in EEPROM 46-47.

Equipment needed:	*Flow and pressure test device,*
	"Cuff" pump
Settings:	*ADU On*
	Pipeline gases connected
	Manual mode
	No gas flows

1. Enter Test Device low pressure range mode (mmHg).
2. Zero the Test Device. The reading on the Test Device should be 0.0.
3. Disconnect fresh gas hose from fresh gas outlet.
4. Remove the vaporizer cassette.
5. Push **Setup** key, select ***Service*** and enter the calibration password. Select ***Calibrations - Vaporizer - Agent pressure.***



```
Cassette Press Calibration
 See instructions from service manual.
     Give reference pressure from
         the pressure gauge (mmHg)
               750

Calibration saved: NO
Last calibration:   8 Feb 2001 11:27
Status: ▸Please, select next task.

                            Scaled
Sensors                     value
Pressure                    (mmHg)
 Counter:                       0
 Circuit:                       0
 Cassette:                    758
```

Figure 42 Vaporizer pressure sensor calibration menu

6. Select ***Start CAL***.
7. Wait 5 seconds.
8. Connect the test equipment to the fresh gas outlet as shown below.

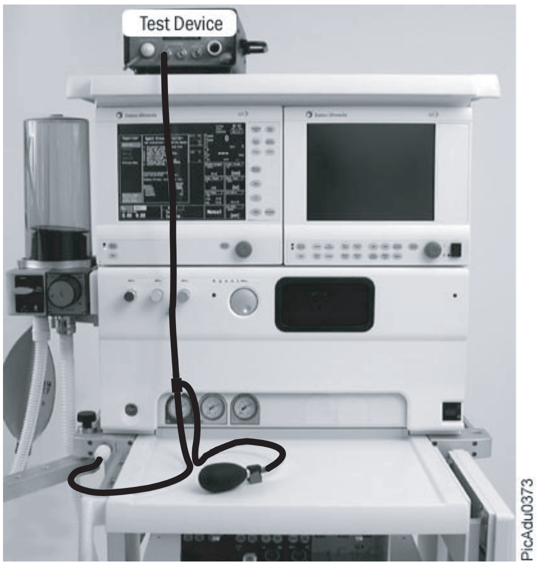


Figure 43 **Vaporizer pressure sensor calibration arrangement**

9. Raise pressure with the cuff pump at the fresh gas outlet to 35-50 mmHg.
10. Select ***Continue***.
11. When status ‘Calibration OK’ is displayed, the calibration may be saved by ***Save CAL*** or abort by selecting ***Abort CAL***. If the status is ‘Calibration failed’, abort the calibration by selecting ***Abort CAL.***
12. Select ***Previous menu***. Perform the needed calibrations according to the Calibration Tree.

Temperature sensor calibration

This calibration calibrates the offset of the temperature sensors. The calculation is linear and the calibration factors for the two sensors are stored in EEPROM 42-43.

Equipment needed *Temperature sensor accuracy at least of ±0.2 °C i.e., S/5 or AS/3 Monitor temperature sensor*

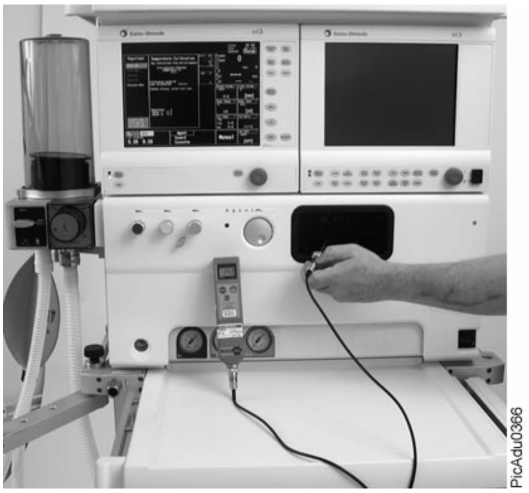
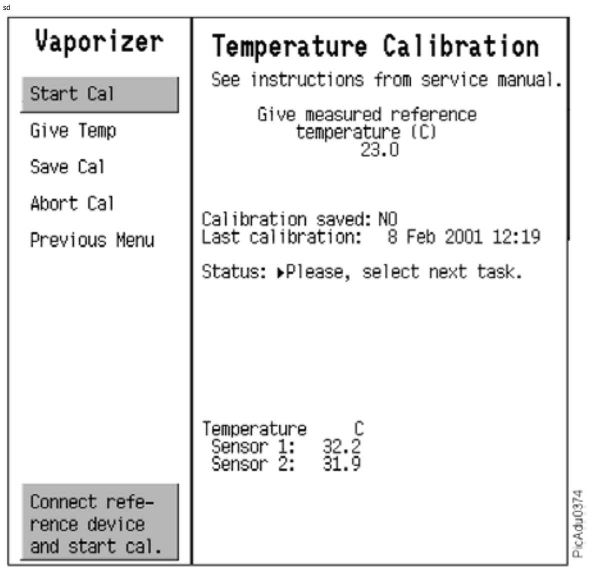


Figure 44 **Temperature sensor calibration**

1. Push the **Setup** key. Select ***Service*** and enter the calibration password. Select ***Calibration - Vaporizer - Temperature.***



Temperature Calibration

See instructions from service manual.

Give measured reference
temperature (C)
23.0

Calibration saved: NO
Last calibration: 8 Feb 2001 12:19

Status: ▸Please, select next task.

Temperature C
Sensor 1: 32.2
Sensor 2: 31.9

Figure 45 Vaporizer temperature sensor calibration menu

2. Take out the Aladin Cassette and put the head of the temperature sensor side by side with the temperature sensor of the vaporizer. (max. distance 1 cm) Let temperature value stabilize at least 5 minutes. Do not hold the reference sensor with your hand, it may warm up and therefore cause an erroneous calibration.
3. Compare the reference temperature and temperature of the sensor 1. If the difference is under ± 0.3 °C, calibration is not needed. If the difference is more, the reference temperature must be given: select ***Start CAL, Give Temp,*** change the correct temperature value and save the calibration by selecting ***Save CAL***.

NOTE: If the reference temperature is increased with more than 1°C the calibration will fail and the calibration menu will be frozen. The only way to proceed is to turn ADU Off/On and make the calibration again. If the reference temperature must be increased with greater than 1°C have this to be done in severally calibrations. But before doing this check your measuring device and measuring point.

4. Select ***Previous menu***. Perform the needed calibrations according to the Calibration Tree.

Agent flow calibration

This calibration calibrates the cassette flow sensor. The calculation is divided in two parts, one second order and one linear calculation. The calibration factors for the safety limit calculation for the agent proportional valve are also calibrated. The calibration factors are stored in EEPROM 25-29. During this calibration the EEPROM 45 value is zeroed and it is calibrated at the first agent delivery check after the calibration.

Equipment needed:	*Calibrated anesthesia monitor (Capnomac Ultima or S/5 Anaesthesia with gas module can be used)* *Filled enflurane or sevoflurane cassette*
Settings:	*ADU On* *Pipeline gases connected* *Manual mode* *APL valve set to 1.5 cm*H_2O *No gas flows* *Scavenging On*

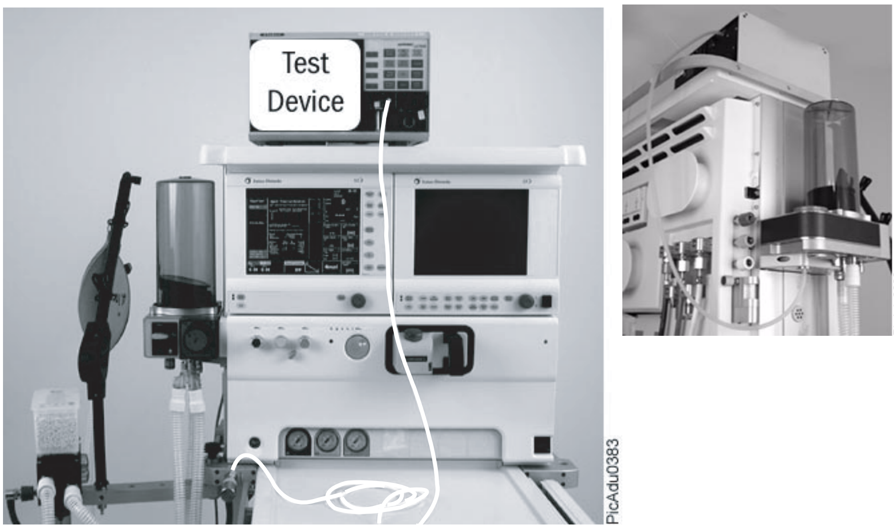


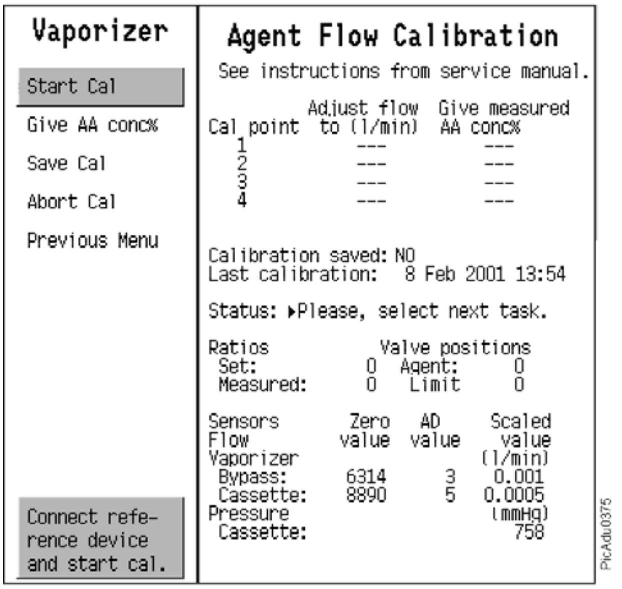
Figure 46 Agent flow calibration

1. Push the ***Setup*** key. Select install and enter the distributor password. Select ***Install - User Config - Ambient pressure.*** Select ***Ambient pressure*** and give external air pressure (see the chart below). The first row shows the height above sea level (meters) and second row shows the atmospheric pressure:

Height (m)	0	200	400	600	800	1000	1200	1400	1600
Pressure (mbar)	1013	988	964	940	917	894	872	850	829

Height (m)	1800	2000	2200	2400	2600	2800	3000	3200	3400
Pressure (mbar)	809	789	769	750	732	714	696	679	662

2. Select ***Service*** and enter the calibration password. Check that all other calibrations are done (see calibration tree in the beginning of this chapter). Then select ***Calibrations - Vaporizer - Agent flow.***



```
Agent Flow Calibration
 See instructions from service manual.

           Adjust flow  Give measured
Cal point  to (l/min)   AA conc%
   1          ---          ---
   2          ---          ---
   3          ---          ---
   4          ---          ---

Calibration saved: NO
Last calibration:   8 Feb 2001 13:54

Status: ▸Please, select next task.

Ratios              Valve positions
 Set:            0   Agent:     0
 Measured:       0    Limit     0

Sensors        Zero    AD     Scaled
Flow           value   value   value
Vaporizer                     (l/min)
 Bypass:       6314     3      0.001
 Cassette:     8890     5     0.0005
Pressure                       (mmHg)
 Cassette:                       758
```

Figure 47 Vaporizer agent flow calibration menu

3. Insert the enflurane or sevoflurane cassette into the slot.
4. Connect the monitor sampling port between the fresh gas hose and the fresh gas outlet.
5. Insert the Aladin cassette ENF/AEV into the fresh gas control unit and flush the cassette approximately 1 minutes by adjusting O_2 flow to 4 l/min. and Enflurane to 5.0%. After flushing, turn agent off and close the flow.
6. Start calibration by selecting ***Start CAL.***
7. Adjust O_2 flow to the first calibration point. Let stabilize until the differences in anesthetic agent concentration percentage on the monitor are maximum one decimal or until the agent valve position on the delivery unit display has stayed unaltered for 5 seconds.
8. Give reference percentage read from the external agent monitor by selecting ***Give AA Conc***. and turning **ComWheel**. Push **ComWheel** to enter the value.
9. Repeat steps 7) and 8) for three more calibration points.
10. After entering the four calibration points, it is essential for successful calibration not to adjust flow controls before the status ‘Calibration OK’ or ‘Calibration Failed’ is displayed (approximately 1 minute). When the status ‘Calibration OK’ is displayed, save the calibration by selecting ***Save CAL*** or abort the calibration by selecting ***Abort CAL***. If the status is ‘Calibration Failed’, abort the calibration by selecting ***Abort CAL***.
11. Close flows and disconnect test equipment
12. Select ***Previous Menu.***Perform the needed calibrations according to the calibration tree.

Flow controls calibrations

N_2O pressure sensor calibration

This calibration calibrates the pressure sensor that is used for detection of the N_2O lost supply pressure. The calculation is linear. The calibration factors are stored in EEPROM 53-54.

Equipment needed: *Flow/pressure test device*
High pressure test adapter

Settings: *Reserve gas cylinders closed*
ADU On
Manual mode
Flows closed
Air/N_2O selector in N_2O position

1. Disconnect the gas inlet hoses O_2, N_2O and Air from the A-WGU (gently because of the high pressure).
2. Enter relevant high pressure range mode on the Test Device.
3. Reset the Test Device. The reading on the Test Device should be 0.0.
4. Connect the high pressure test adapter and Test Device as shown below.

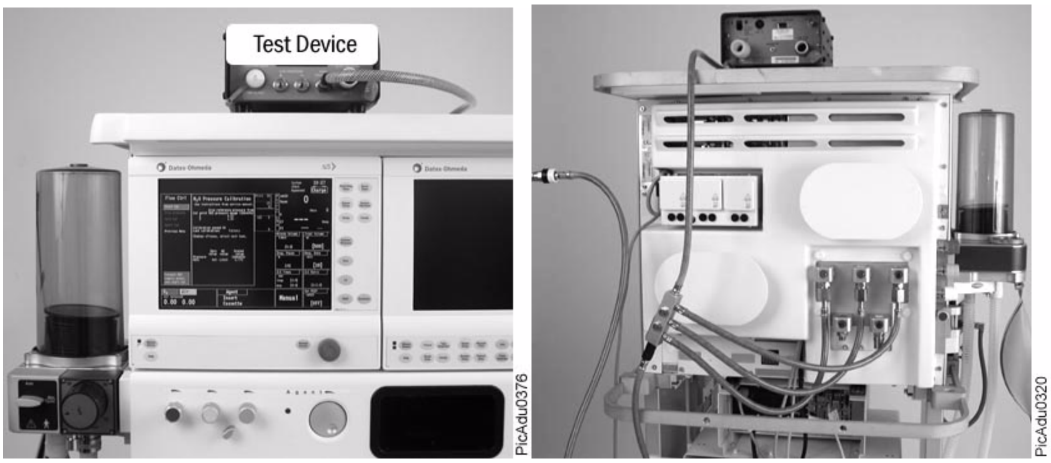
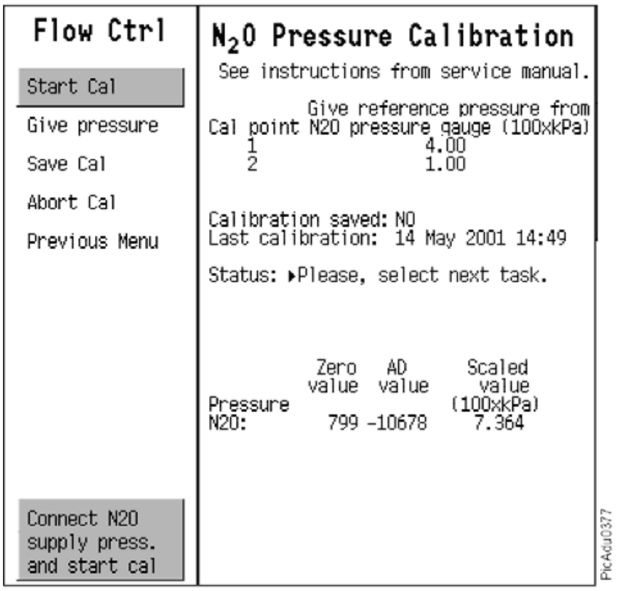


Figure 48 N_2O pressure sensor calibration arrangement

5. Push the **Setup** key. Select ***Service*** and enter calibration password. Select ***Calibrations - Flow controls - N_2O Pressure.***



```
N2O Pressure Calibration
 See instructions from service manual.

          Give reference pressure from
Cal point N20 pressure gauge (100xkPa)
    1                4.00
    2                1.00


Calibration saved: NO
Last calibration:  14 May 2001 14:49

Status: ▸Please, select next task.



          Zero   AD      Scaled
          value  value    value
Pressure                (100xkPa)
N20:        799 -10678    7.364
```

```
Connect N20
supply press.
and start cal
```

Figure 49 N_2O **pressure sensor calibration menu**

6. Start calibration by selecting ***Start Cal***.
7. Read pressure from the Test Device and Give correct reference pressure to calibration point 1 (100×kPa).
8. Disconnect the high pressure test adapter from the central outlet and the A-WGU.
9. Reconnect the O_2 and Air pipeline pressure to the A-WGU (leave the N_2O pipeline pressure disconnected from the ADU).
10. Set the O_2 flow control to 1 l/min.
11. Open the N_2O flow control to depressurize the pressure.
12. Check that the N_2O flow indicate 0.0 on the ADU display.
13. Give reference pressure 0.0 to calibration point 2 (100xkPa).
14. Wait until ‘Calibration OK’ or ‘Failed’ is displayed.
15. Save the calibration by selection ***Save CAL.*** To abort calibration, select ***Abort CAL***.
16. Reconnect the N_2O pipeline pressure to the ADU.
17. Select ***Previous Menu***. Perform the needed calibrations according to the calibration tree.

Counter pressure sensor calibration

This calibration calibrates the zero point of the counter pressure sensor. During this calibration the mixer flow has to be below 100 ml/min. The calibration factor is stored in EEPROM 35.

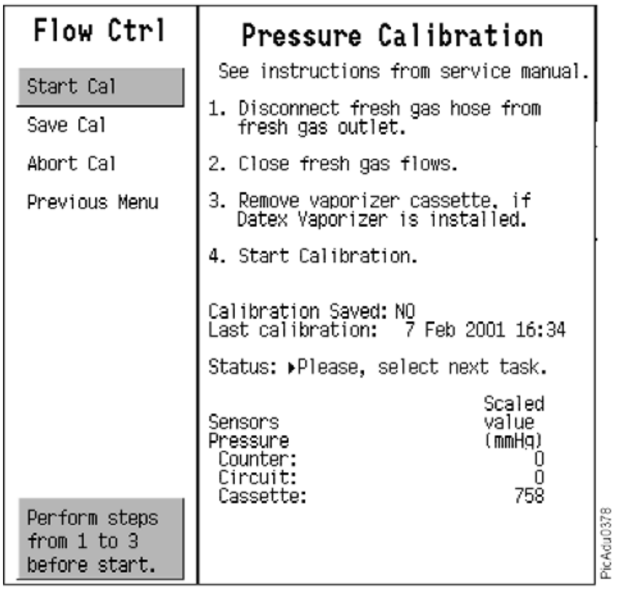
Settings: *ADU On*

Gas inlets connected to central outlets

Manual mode

No gas flows

1. Push the **Setup** key. Select ***Service*** and enter calibration password. ***Select Calibrations - Flow controls - Pressure.***



```
Perform steps
from 1 to 3
before start.
```

Pressure Calibration

See instructions from service manual.

```
1. Disconnect fresh gas hose from
   fresh gas outlet.
2. Close fresh gas flows.
3. Remove vaporizer cassette, if
   Datex Vaporizer is installed.
4. Start Calibration.

Calibration Saved: NO
Last calibration:   7 Feb 2001 16:34

Status: ▸Please, select next task.

                              Scaled
Sensors                       value
Pressure                      (mmHg)
 Counter:                          0
 Circuit:                          0
 Cassette:                       758
```

Figure 50 Counter Pressure Sensor calibration

2. Disconnect the fresh gas hose from the fresh gas outlet.
3. Remove the vaporizer cassette.
4. Start calibration by selecting ***Start CAL***.
5. When the status ‘Calibration OK’ is displayed, you can save the calibration by selecting ***Save Cal*** or abort the calibration by selecting ***Abort Cal***. If the status is ‘Calibration Failed’, abort the calibration by selecting ***Abort CAL***.
6. Select ‘Previous Menu’. Perform the needed calibrations according to the calibration tree.

O_2 flow sensor and bypass flow calibration

This calibration calibrates the oxygen flow sensor, the bypass flow sensor for oxygen and the counter pressure sensor for oxygen, which is used for the occlusion alarm. The flow calculation is divided in two parts, one second order and one linear calculation. The calibration factors are stored in EEPROM 1-8 and 56-57.

Equipment needed:	*Flow test device*
Settings:	*ADU On*
	Pipeline gases connected
	Manual mode
	No gas flows

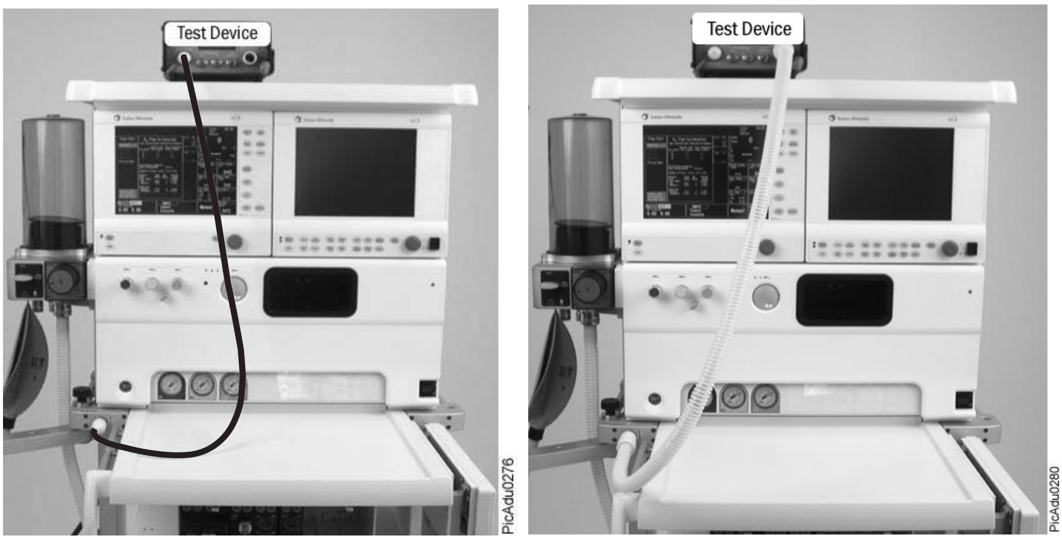
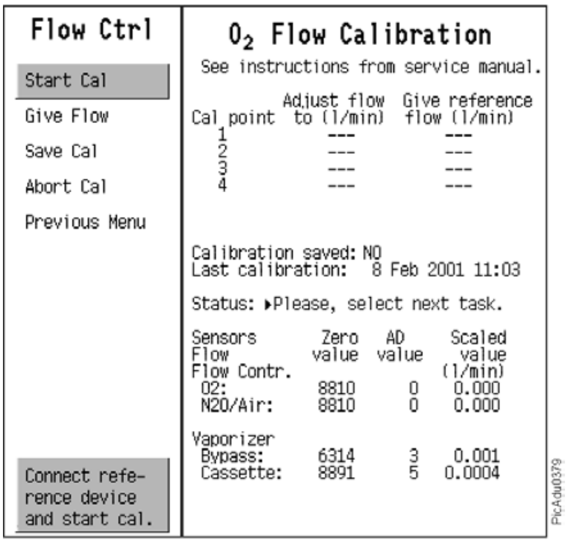


Figure 51 **Low flow calibration setup (to the left) and high flow calibration setup (to the right)**

1. Push the **Setup** key. Select ***Service*** and enter calibration password. Select ***Calibration - Flow controls - O_2***



```
O2 Flow Calibration
 See instructions from service manual.

           Adjust flow  Give reference
Cal point  to (l/min)   flow (l/min)
   1          ---          ---
   2          ---          ---
   3          ---          ---
   4          ---          ---

Calibration saved: NO
Last calibration:   8 Feb 2001 11:03

Status: ▸Please, select next task.

Sensors          Zero    AD      Scaled
Flow             value   value    value
Flow Contr.                      (l/min)
 O2:             8810       0     0.000
 N2O/Air:        8810       0     0.000

Vaporizer
 Bypass:         6314       3     0.001
 Cassette:       8891       5    0.0004
```

Connect reference device and start cal.

Figure 52 **O_2 Flow Sensor Calibration menu**

2. Connect the Test Device to the fresh gas outlet with a tube. Test Device should be set to O_2 low flow range. Zero the Test Device before connecting the tube.
3. Start calibration by selecting ***Start Cal***.
4. Adjust O_2 flow (read on the ADU display) to the first calibration point (1 l/min.). Let stabilize for a minute.
5. Give reference flow (read on the Test device) by selecting Give Flow and turning **ComWheel**. Push **ComWheel** when the given O_2 flow corresponds the flow from the Test Device.
6. Repeat step 4 for three more calibration points 3.0, 7.0 and 11.0 l/min. (for 7.0 and 11.0 l/min. select high O_2 flow range on the Test Device and connect a larger tube). Zero the Test Device before connecting the tube.
7. When the status 'Calibration OK' is displayed, you can save the calibration by selecting ***Save CAL*** or abort the calibration by selecting ***Abort CAL***. If the status is 'Calibration failed', abort the calibration by selecting ***Abort CAL***.
8. Close flow controls.
9. Select ***Previous menu***. Perform the needed calibrations according to the Calibration Tree.

N_2O/Air flow sensor calibration

This calibration calibrates the N_2O/Air flow sensor, the bypass flow sensor for N_2O and the counter pressure sensor for N_2O and Air, which is used for the occlusion alarm. The flow calculation is divided in two parts, one second order and one linear calculation. The calibration factors are stored in EEPROM 9-12, 17-24 and 58-61.

Note: The flow sensor needs to be calibrated with both Air and N_2O flow.

Equipment needed: *Flow test device*

Settings: ADU On

Pipeline gases connected

Manual mode

No gas flows

N_2O / Air selector in Air position

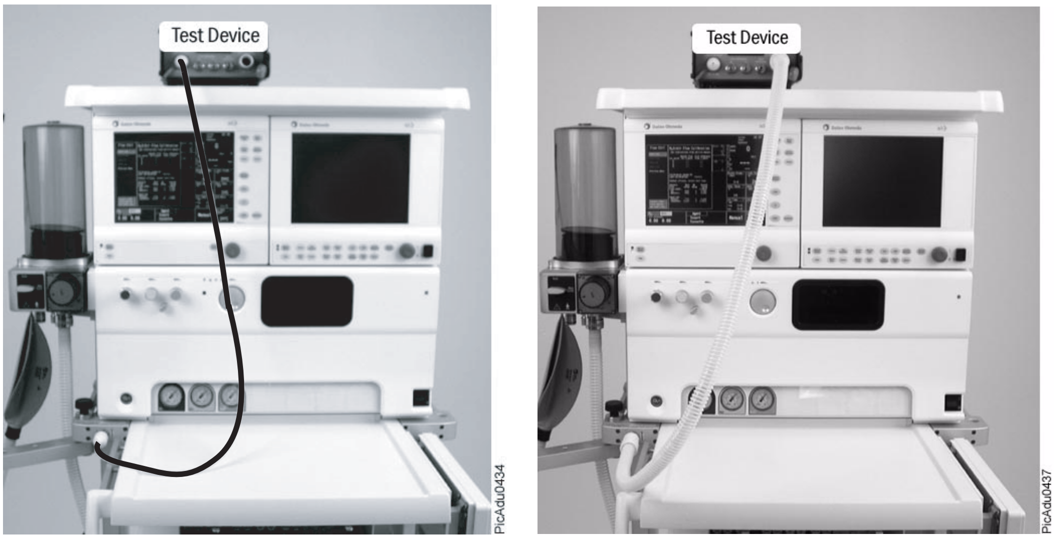
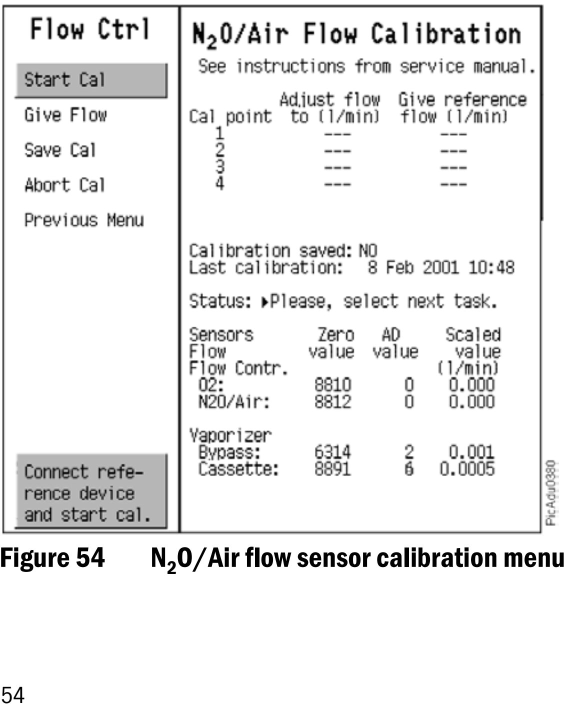

Test Device
PicAdu0434
Test Device
PicAdu0437

Figure 53 **Low flow calibration setup (to the left) and high flow calibration setup (to the right)**


Flow Ctrl
Start Cal
Give Flow
Save Cal
Abort Cal
Previous Menu
Connect refe-
rence device
and start cal.
PicAdu0380

```
N2O/Air Flow Calibration
 See instructions from service manual.
              Adjust flow  Give reference
Cal point  to (l/min)   flow (l/min)
  1           ---          ---
  2           ---          ---
  3           ---          ---
  4           ---          ---

Calibration saved: NO
Last calibration:   8 Feb 2001 10:48

Status: ▸Please, select next task.

Sensors        Zero    AD     Scaled
Flow           value  value    value
Flow Contr.                   (l/min)
 O2:           8810     0     0.000
 N2O/Air:      8812     0     0.000

Vaporizer
 Bypass:       6314     2     0.001
 Cassette:     8891     6     0.0005
```

Figure 54 **N_2O/Air flow sensor calibration menu**

1. Push the **Setup** key. Select ***Service*** and enter calibration password. Select ***Calibration - Flow controls - N_2O & Air***. Connect the Test Device to the fresh gas outlet with a tube (Test Device set to Air low flow range). Zero the Test Device before connecting the tube.
2. Start calibration by selecting ***Start CAL.***
3. Adjust air flow (read on the ADU display) to the first calibration point (1.0 l/min.). Let value stabilize.
4. Give reference flow (read on Test Device) by selecting Give Flow and turning **ComWheel**. Push **ComWheel** when the given air flow corresponds to the flow in Test Device.
5. Repeat steps (4) and (5) for three more calibration points at 3.0, 7.0 and 11.0 l/min. (for 7.0 and 11.0 l/min. select air high flow range on Test Device and connect a larger tube). Acceptable reference values are within ± 15% of the requested calibration points.
6. When the status 'Calibration OK' is displayed, you can save the calibration by selecting ***Save CAL*** or abort the calibration by selecting ***Abort CAL***. If the status is 'Calibration Failed', abort the calibration by selecting ***Abort Cal***.
7. Close Air flow control and turn N_2O/Air Selector in position N_2O.
8. Setup Test Device to N_2O flow range measurement, with the Test Device set for appropriate low or high flow measuring range and repeat steps 4 to 7 with N_2O.

NOTE: Maximum N_2O flow 11 l/min. may not be attained even with the N_2O flow control fully open. This is not a fault proceed with the calibration as long you can attain 9.5l/min. If below 9.5l/min. check first the pipeline inlet pressures is in specifications and secondly adjust the N_2O regulator as step A-C below.

A) Remove the rear plastic cover (8 Allen screws), fold down the gas inlet part on the A-WGU (2 Allen screws) and open the rear cover of the fresh gas control unit (9 Pozidriv screws).

B) Adjust the screw on the top of the N_2O pressure regulator until the flow indicates 10l/min. on the test device.

C) Refit covers in reversed order after adjustment.

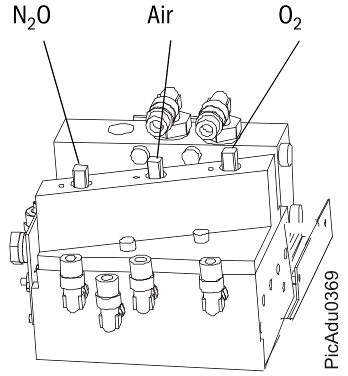


Figure 55 A-FGC1 Pressure regulators

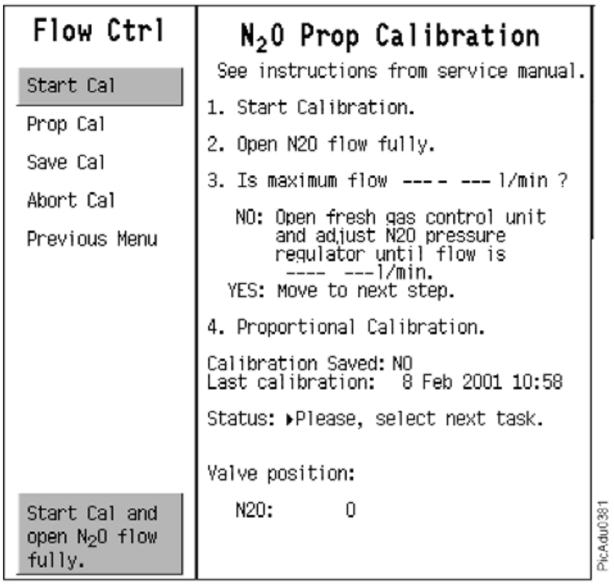
9. Select ***Previous menu***. Perform the needed calibrations according to the Calibration Tree.

N_2O proportional function and pressure regulator adjustment

This calibration calibrates the N_2O proportional valve drive and the N_2O pressure regulator is adjusted for proper maximum flow. The factors are used in the valve controller function and for calculating the safety limit of the valve. The calibration factors are stored in EEPROM 31 and 33-34.

Equipment needed:	*Flow and pressure test device*
	Pozidriv cross-head screwdriver
	Allen 4 mm
Settings:	*ADU On*
	Pipeline gases connected
	Manual mode
	No gas flows
	N_2O / Air selector in N_2O position

1. Select the N_2O high flow measurement range on the test device. Zero the test device.
2. Connect a hose between the test device high flow range inlet and fresh gas outlet on ADU.
3. Push the **Setup** key. Select ***Service*** and enter calibration password. Select ***Calibrations - Flow controls - N_2O Prop.***



```
N2O Prop Calibration
 See instructions from service manual.
1. Start Calibration.
2. Open N2O flow fully.
3. Is maximum flow ---- --- l/min ?
   NO: Open fresh gas control unit
       and adjust N2O pressure
       regulator until flow is
        ----  ---l/min.
  YES: Move to next step.
4. Proportional Calibration.
Calibration Saved: NO
Last calibration:   8 Feb 2001 10:58
Status: ▸Please, select next task.

Valve position:
   N2O:       0
```

Figure 56 **N_2O proportional function calibration menu**

4. Start calibration by selecting ***Start CAL***.
5. Open fully the N_2O flow.

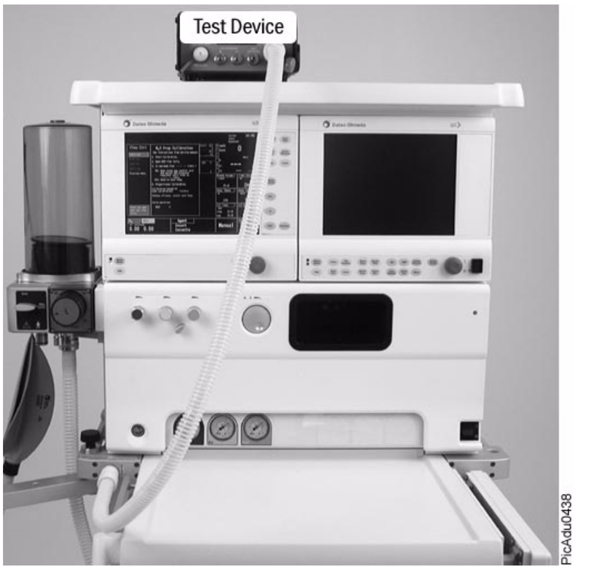


Figure 57

6. If the maximum flow on the Test Device is within the given limits on diagnostic page, go to step 8. If the maximum flow is not within the given limits, remove the rear plastic cover (8 Allen screws). Fold down the gas inlet part on the A-WGU (2 Allen screws) and open the rear cover of the fresh gas control unit (9 Pozidriv screws open the upper back panel and fresh gas control unit.
7. Adjust the screw on the top of the N_2O pressure regulator until the flow is within the given limits. Refit covers in reverse order after adjustment.

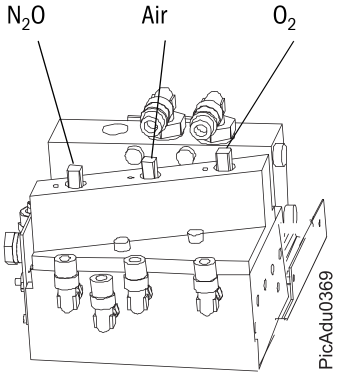


Figure 58 **A-FGC1 Pressure regulators**

8. Select ***Prop CAL***. Wait for 30 seconds.
9. When the message ‘Calibration OK’ is displayed, save the calibration by selecting ***Save CAL*** or abort the calibration by selecting ***Abort CAL***. If the status is ‘Calibration Failed’, abort the calibration by selecting ***Abort CAL***.
10. Close flow controls.
11. Select ***Previous Menu***. Perform the other calibrations required in the Calibration Tree.

TROUBLESHOOTING A-FGC1

Beware that when recommendations in text below is to calibrate a specific part shall always the other needed calibrations be done according to the calibration Tree in Part II section 3.

Before starting to use this table we recommend to first find out when the problem occurred i.e. date and time and then check into the service error log or system check error log to find which errors was stored into the log at that date and time.

If the ADU not have been switched off there will also be valuable information stored in the User alarm log.

Error messages

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Hypoxic mixture	FGC Low O_2 percent	Calculated O_2% is below 20% for more than 5s. The total flow has to be > 30 ml/min.	1) High anaesthetic percentage mixed with plain air (User action). 2) N_2O proportional valve faulty. 3) N_2O/Air Selection valve leaks air into the N_2O line.	1) Decrease set anaesthetic concentration. 2) Check the N_2O proportional valve and N_2O/Air Selection valve by performing N_2O delivery check. 3) Calibrate N_2O proportional valve. 4) Replace N_2O proportional valve / N_2O/Air Selection valve.	x
Vapour. leak Cassette Service?	FGC Leak	Vaporizer flow (bypass + agent flow) is 16.5% smaller than the mixer flow (O_2 + sidegas). The alarm is disabled if the flow is changing.	1) Leak in the Aladin or in the connections between Aladin and A-FGC1. 2) Flow measurement failure in some of the four measurement units (O_2, sidegas, bypass or cassette flow).	1) Aladin not locked correctly in the A-FGC1 housing. 2) Check the Aladin connection valves O-rings. 3) Check with other Aladin. 4) Perform a flow comparison on the A-FGC1 diagnostic page to see if there are any mismatches between the flows. 5) Calibrate A-FGC1 6). Replace faulty Flow measurement unit and calibrate the A-FGC1.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Vapor. leak Cassette? Service?	FGC Big leak If staus remains for two minutes the A-FGC goes to Safe state.	Vaporizer flow (bypass + agent flow) is 33% smaller than the mixer flow (O_2 + sidegas). The alarm is disabled if the flow is changing before 2 minutes.	1) Leak in the Aladin or the connections between Aladin and A-FGC1. 2) Flow measurement failure in some of the four measurement units (O_2, sidegas, bypass or cassette flow).	1) Aladin not locked correctly in the A-FGC1 housing. 2) Check the Aladin connection valves O-rings. 3) Check with other Aladin. 4) Perform a flow comparison on the A-FGC1 diagnostic page to see if there are any mismatches between the flows. 5) Calibrate A-FGC1 6) Replace faulty Flow measurement unit and calibrate the A-FGC1.	x
FGC gas occlusion. FG outlet	FGC Occlusion	Measured counter pressure is bigger than calculated theoretical maximum counter pressure (p= A*flow^2 +B + 60 mmHg where, for O_2 A= EEPROM 56 B= EEPROM 57 for AIR A= EEPROM 58 B= EEPROM 59 for N_2 O A= EEPROM 60 B= EEPROM 61	1) Occlusion in the A-FGC1 pneumatics. 2) Counter pressure measurement failure.	1) Open the O_2 and Air flow control to maximum and check if alarm occurs when use of the Oxygen flush. If so can problem be due to that the Oxygen flush flow is set to high (A-WGU-00 max 35l/min.) 2) Check that the counter pressure sensor indicate 0 on the diagnostic page when fresh gas flows are closed and the fresh gas outlet are open to the ATM. If not near zero calibrate the sensor. 3) Calibrate the A-FGC1	x

Message in Normal Screen	**Message in diagnostic page**	**Error condition**	**Possible cause**	**Recommended action**	**Err log**
Cannot identify cassette.	FGC Agent id. error	Aladin identification does not match any cassette.	Identification board or cable failure. 2) Aladin coding failure. 3) Check Aladin locking mechanism	Replace identification board. 2) Replace Aladin 3) Check that the Identification board is correct mounted and that the board HALL sensors it's aligned to the magnets in the Aladin.	x
AA liquid sensor failure	FGC Level sens err	Liquid level sensor output voltage is at maximum (10V)	Module or Aladin level sensor board failure.	Replace Aladin cassette Replace Agent level board in A-FGC1	x
Vaporizer failure Agent shut-off	FGC Agent ctrl err	The measured ratio is continuously bigger than the set ratio.	1) Agent proportional valve failed to close. 2) Cassette flow measurement failure.	1) Check the agent proportional valve operation on diagnostic page. (ratio and set can be seen on the diagnostic page) 2) Calibrate agent flow. 3) Replace agent proportional valve and calibrate the Agent flow.	x
Vaporizer failure Agent shut-off	FGC Liq flow err	Agent proportional valve drive exceeds continuously the valve drive safety limit. Liquid prevention valve causes restriction in the flow channel	1) Agent proportional valve does not open. 2) Inlet/outlet close valve. 3) Liquid prevention valve	1) Calibrate the Agent flow. 2) Check the agent proportional valve operation from diagnostic page. Check inlet/out-let close valve. Check Liquid prevention valve.	x
Vaporizer failure Agent shut-off	FGC Liq offs err	Cassette flow measurement zero point drift. Note: Error applies from Main SW version 6.1 and 7.1	Faulty cassette flow zeroing valve	1) Replace cassette flow zeroing valve.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Vaporizer failure Agent Shut-off	FGC Cass press err	Cassette pressure sensor signal is 0V or the measured pressure is over 600 + vapor pressure [mmHg]	Pressure sensor failure.	1) Replace the Cassette pressure sensor.	x
Vaporizer failure Agent Shut-off	Vaporizer failure See related messages				
Vaporizer failure Agent Shut-off	Casspr offs err	The zero point signal of cassette pressure measurement sensors is 0V or more then 4V. Note: Error applies from Main SW version 6.1 and 7.1	Cassette pressure sensor failure.	Replace the cassette pressure sensor board.	x
Vaporizer failure. Agent Shut-off	Shunt offs err	The zero point signal of bypass flow measurement sensors is 0V or more then 4V. Note: Error applies from Main SW version 6.1 and 7.1	Bypass flow sensor failure.	Replace the bypass flow sensor board.	x
Vaporizer failure. Agent Shut-off	Shunt zero error	Bypass flow measurement zero point drift 400 ADC. Note: Error applies from Main SW version 6.1 and 7.1	Bypass flow measurement failure.	Replace bypass flow measurement unit zeroing valve. Check the bypass flow measurement unit.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Vaporizer failure. FGC safe state after 2 minutes.	O_2 zero error	O_2 flow measurement zero point drift 500 ADC. Note: Error applies from Main SW version 6.1 and 7.1	O_2 flow measurement failure.	Replace the O_2 flow measurement zeroing valve. Check the O_2 flow measurement unit.	x
Vaporizer failure. FGC safe state after 2 minutes.	Sg zero error	Sidegas flow measurement zero point drift 500 ADC. Note: Error applies from Main SW version 6.1 and 7.1	Sidegas flow measurement failure.	Replace the sidegas flow measurement unit Zeroing valve. Check the mixer flow measurement unit, sidegas.	x
Vapouriser failure	FGC Mixer 0 unstab.	Zero value not stable during zeroing	1) Leaking zeroing valve. 2) Faulty flow transducers.	1) Check the mixer zeroing valves and flow transducers	x
Agent % not delivered Decr.flow.	FGC Insuffic. agent	The measured ratio is continuously smaller than the set ratio and agent proportional valve drive is at maximum (>4000).	1) The required concentration is out of reach at the current total flow and cassette temperature. 2) Agent proportional valve is fully open or stuck closed i.e. not cap-able of increasing the agent flow due to an agent channel occlusion or valve failure.	1) Decrease total flow or anaesthetic concentration 2) Check the agent proportional valve operation and vaporizer maximum output.	x
N_2O supply pressure lost		Measured N_2O supply pressure is below 2.4 bar	N_2O supply pressure has decreased.	1) Increase the pressure.	
Fresh gas unit failure	Safe state	Safe state: The AA and N_2O deliveries are interrupted. The gas selection valve is switched to Air position.	Major electronics or flow measurement failure. Message is always related to other failure.	1) See related messages.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Fresh gas unit failure	FGC RAM error Safe state	RAM error detected	Corrupted RAM circuit.	1) Replace the CPU board.	x
Fresh gas unit failure	FGC ROM error Safe state	ROM error detected. Check is done only in start-up.	Corrupted ROM (program) circuit.	1) Replace the CPU board	x
Fresh gas unit failure	FGC EPROM error Safe state	EEPROM error detected. Check is done only in start-up or while saving new calibration data.	Corrupted EEPROM circuit.	Replace the EPROM Replace the CPU board	x
Fresh gas unit failure	FGC A/D conv. Error Safe state	All the measured supply voltages drift more than 10% from nominal.	Corrupted AD converter circuit	1) Replace the CPU board	x
Fresh gas unit failure	FGC Power failure Safe state	One or more measured supply voltages drift more than ±10% from nominal.	Power supply failure	1) Check the supply voltages on the FGC diagnostic page. 2) Check DC/DC board fuses. 3) Check the power supply, main electronics supply voltage, interface cable, CPU board.	x
Fresh gas unit failure	FGC HW watchdog err Safe state	HW watchdog failed to reset the processor in start-up test.	1) Watchdog circuit failure	Replace the CPU board.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Calibrate fresh gas unit	FGC Factory def	One or more calibrations not done.	1) New EEPROM installed. 2) EEPROM cleared manually. 3) EEPROM failure	1-2) Calibrate the A-FGC1. 3) Replace EEprom or the CPU board	x
Select N_2O or Air	N/A	Both the sidegas switch input bits are zero.	1) Switch is stuck in between the two allowed states (User action). 2) Switch cable loose. 3) Electronics failure.	1) Replace the side gas 2) Check that cable is correct connected to the connection board 3) Replace the CPU board	
Faulty N_2O / Air switch	N/A	Both the sidegas switch input bits are set.	Broken switch or electronics failure.	1) Replace the side gas switch. 2) Replace the CPU board.	
Fresh Gas Unit meas. error	FGC Flow error	Vaporizer flow (bypass + agent flow) is 16.5% bigger than the mixer flow (O_2 + sidegas). The alarm is disabled if the flow is changing.	Flow measurement failure in some of the four measurement units (O_2, sidegas, bypass or cassette flow)	1) Perform a flow comparison on the A-FGC1 diagnostic page to see if there are any mismatches between the flows. 2) Calibrate A-FGC1 3) Replace faulty Flow measurement unit and calibrate the A-FGC1.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Fresh Gas Unit meas. Error	FGC Big flow error If status remains for 2 minutes the A-FGC goes to Safe state.	Vaporizer flow (bypass + agent flow) is 33% bigger than the mixer flow (O_2 + sides. The alarm is disabled if the flow is changing.	Flow measurement failure in some of the four measurement units (O_2, sidegas, bypass or cassette flow) A-FGC1 Big flow error may also indicate that the O_2 or side gas Zeroing valve have failed.	1) Perform a flow comparison on the A-FGC1 diagnostic page to see if there are any mismatches between the flows. 2) Calibrate A-FGC1 3) Replace faulty Flow measurement unit and calibrate the A-FGC1	x
Fresh Gas Unit meas. error	FGC Contr. press fail	1) Counter pressure sensor output voltage is 0V or 10V at total flows < 10 l/min. 2) Measured counter pressure is 0 at bypass flow > 1 l/min.	Faulty counter pressure sensor.	1) Check the counter pressure sensor on the diagnostic page. 2) Replace the counter pressure sensor.	x
Decrease fresh gas flow	FGC Max. flow viol	The measured total flow is > 20 l/min	1) Regulators wrong adjusted. 2) Flow measurement failure.	1) Check and adjust the regulators. Check the flow measurement units.	x

Message in Normal Screen	Message in diagnostic page	Error condition	Possible cause	Recommended action	Err log
Agent shut OFF	N/A	Anaesthetic delivery is closed independent of the anaesthetic setting. Bypass flow decreased below 150 ml/min. while anaesthetic is on. 2) Cassette is removed while anaesthetic is on. 3) Message is related to other failures. See related messages.	1) User action 2) Related to another failure. (O_2 pressure lost....etc)	1) See related messages	
Air selected	N/A	A-FGC1 has switched the N_2O/Air selection valve to Air independent of the switch position.	Message is always related to another failure. (N_2O pressure lost)	1) See related messages.	
Draining Cassette (Red alarm)	FGC Cass overfilled	Measured liquid level is 60% over the cassette full limit.	1) Aladin is overfilled. 2) Module or Aladin liquid level board failure.	1) Check the liquid level in the Aladin. Check the both level sensor boards and the connector.	x
Draining Cassette (Yellow alarm)	FGC Cass overpress	Cassette gauge pressure is over 1200mmhg (1.6bar) bar	1) Heated Desflurane cassette (>45C).	1) Wait the pressure to be released to the scavenging.	x

System check

System check process percentages

At power up, the unit checks various electronics such as processor and watchdog. The content from the EEPROM is loaded into the RAM. The unit exercises the Zero 1 and Zero 2 valves 10 times.

NOTE: Percentage has references to what are found in the system check log

N_2O delivery test

Percentage of test	Which valves are operated	What is being tested	How test is done	Suggested actions if test fails
0 - 10	O_2 test valve is opened. The N_2O proportional valve is energized. The N_2O needle valve has to be manually opened to over 6 l/min.	The N_2O needle valve and the N_2O proportional valve.	Looks for a flow of greater than 6 l/min. through the sidegas flow transducer. If it can not deliver enough flow, it remains in this test.	Check O_2 and N_2O pipeline pressure is within specification. O_2 test valve faulty.
11 - 40	The 02 test valve and the N_2O needle valve remain open. The N_2O proportional valve is closed.	This test verifies that the N_2O proportional valve can shut off the flow of N_2O.	The sidegas flow transducer should indicate a flow less than 60ml/min. If the test fails, **35%** is stored in the system check error history.	Check flows with a Test device. Check flows and N_2O proportional valve on diagnostic page. 2. Calibrate the A-FGC1.
41-50	The 02 test valve and the N_2O needle valve remain open. The N_2O proportional valve is reopened.	This test verifies that the N_2O proportional valve has reopened.	The sidegas flow transducer should indicate a flow of at least 5 l/min. If the test fails, **48%** is stored in the system check error history.	Check the O_2 and side gas flows with a Test device. Calibrate the A-FGC1.
51-100	The 02 test valve, the N_2O proportional valve and the N_2O needle valve remain open. The N_2O/Air selection solenoid is placed in the Air position.	This test verifies that selecting Air can shut off the N_2O flow.	The microprocessor in the Fresh Gas Control unit de-energizes the N_2O selection valve. Looks for a flow through the sidegas transducer. If there is still a flow, this indicates that there is N_2O flowing and it has not switched to Air.	1 Check voltage to the N_2O/Air solenoid valve. 2. Replace the N_2O/Air selection valve.

System check agent delivery

% of agent delivery test	Which valves are operated	What is being tested	Description of test	Technical suggested actions
0-9	Closes the in, Out and Scavenging valve. Exercises the In, Out, and Scavenging valve. Opens the O_2 Test Valve.	Checks that the fresh gas flow if turned off. Checks for cassette I.D. and confirms that one is present. If Desflurane, it see if the cassette is empty.	SW checks if cassette is inserted. If there no cassette or if Desflurane cassette empty. **Agent Cassette 1%** will be stored in the system check error history.	Check cassette connection to A-FGC1. If no identification is present even when the Aladin cassette is installed correctly. There can be a failure in the cassette identification board, A-FGC1 connection board, A-FGC1 CPU board or Aladin cassette Fill cassette (only valid for Desflurane). Check that O_2 test valve is giving a flow between 5-7 l/min. when open. Check with other cassette.

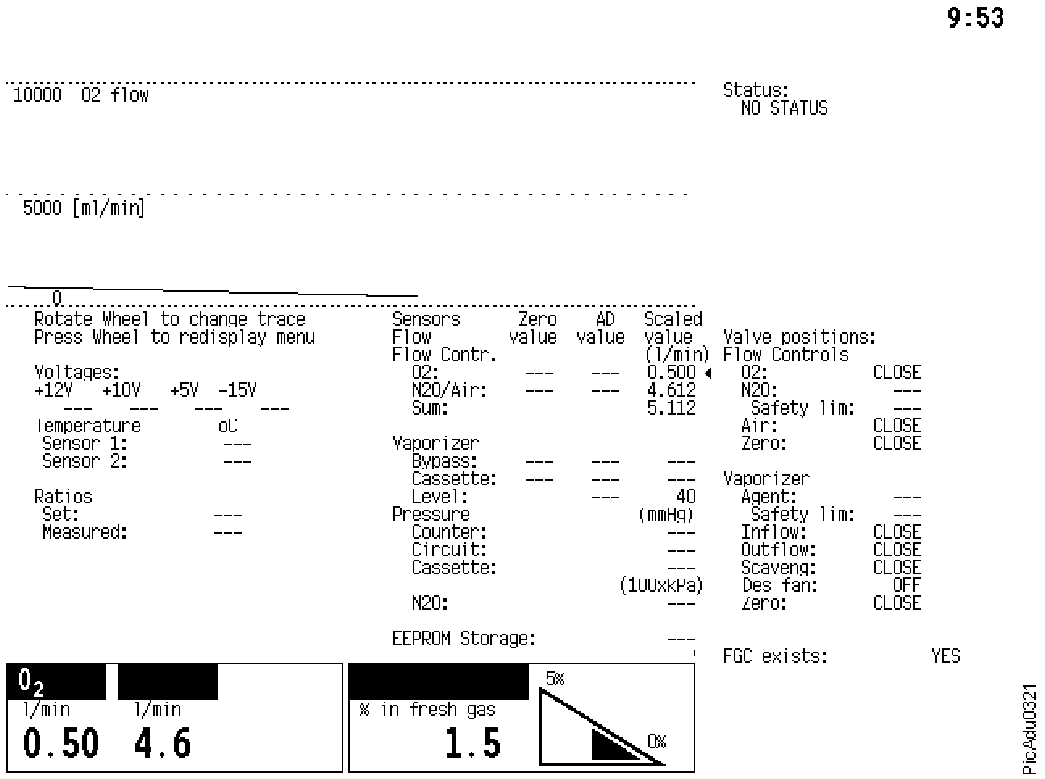
% of agent delivery test	Which valves are operated	What is being tested	Description of test	Technical suggested actions
10-19	O_2 Test valve is open. Scavenging valve is opened partially during the test.	Checks that the scavenger valve is opened and verifies that the Inlet valve is not leaking.	Measures the counter pressure and by-pass flow. After opening up the scavenging valve, the unit checks that the Cassette pressure is at least 30mmHg lower than the counter pressure and that the by-pass flow has not decreased by more than 100 ml/min. If scavenging valve fails will **14%** be stored in the system check error history. If the inlet valve test fails will **17%** be stored in the system check error history.	If failed at 14% Check cassette pressure sensor calibration on the A-FGC1 diagnostic page by verifying that *cassette pressure minus install pressure = equal to counter pressure (+30mmHg).* If not equal calibrate Cassette pressure sensor, Agent flow and repeat the test Scavenging valve does not open. Check valve in the A-FGC1 diagnostic page. Replace scavenging valve. If failed at 17% Indicates that the Inflow close valve leaks, Replace inflow close valve.

% of agent delivery test	Which valves are operated	What is being tested	Description of test	Technical suggested actions
20-29	The O_2 Test valve is opened. Scavenging valve is closed and the inlet valve is opened.	Checks that the scavenger valve closes and that the inlet valve is opened.	For all agents except Desflurane, Is the counter pressure and the cassette pressure compared, they should be within 30mmHg of each other. The test for Desflurane is more rough and checks if the difference between the cassette pressure and calculated vapor pressure is larger than 500mmHg. If the test fails will **28%** be stored in the system check error history.	If failed at 28% ALADIN cassette leaks or the connection between A-FGC1 and cassette. Verify on A-FGC1 diagnostic page. Check cassette pressure sensor calibration on the A-FGC1 diagnostic page by verifying that *cassette pressure minus install pressure = equal to counter pressure (+30mmHg).* If not equal calibrate Cassette pressure sensor, Agent flow and repeat the test Recalibrate Cassette pressure sensor board. Scavenging valve leaks; replace valve.
30-39	The inlet valve and the O_2 test valve remain open.	Checks for a leak in the cassette.	If the bypass flow is 4% less than the previous test (10-14%) indicates this a leak in the cassette. Repeats the previous cassette pressure test (20-29%). If the leak test fails will **33%** be stored in the system check error history. If the pressure test fails will **35%** be stored in the system check error history.	If failed at 33% Leakage in cassette or connection between cassette and A-FGC1. If failed at 35% See suggestion at 28% 1-3

% of agent delivery test	Which valves are operated	What is being tested	Description of test	Technical suggested actions
40-49	The inlet valve and the O_2 test valve remain open. The agent proportional valve is also opened fully.	Checks for a leak in the outflow valve.	If there is more than a 100ml flow through the agent flow transducer, the test fails. If the test fails will **42%** be stored in the system check error history.	If failed at 42% Indicate that outflow close valve leaks Replace outflow close valve.
50-59	Both the in flow and Out flow valves are opened. O_2 test valve is opened. Agent proportional valve is closed.	Checks for leak in the proportional valve.	A flow greater than 100ml through the agentflow transducer would indicate a leak in the agent proportional valve. If the test fails will **52%** be stored in the system check error history.	If failed at 52% Calibrate Agent flow and test again. Replace Agent proportional valve and calibrate again.

% of agent delivery test	Which valves are operated	What is being tested	Description of test	Technical suggested actions
60-69 and 70-79 (70-79 is repetition of previous test 60-69%)	Both the in flow and Out flow valves are opened. O_2 test valve is open. Agent proportional valve is opened partially through the test.	Checks to see if the agent proportional valve and outlet valve are operational.	Measure the mixer flow (sidegas + O_2) and opens the agent proportional valve to get a flow of approximately 400 ml/min. based on the calibration factors of the valve. If the agent flow is less than 200 ml/min., the test fails and **61%** or **71%** will be stored in the system check error history**.** If calculated vaporizer flow differs more than 40% to measured vaporizer flow the test fails and **69%** or **79%** will be stored in the system check error history. For Desflurane is the test done in a slightly different way by setting the agent proportional valve to a calculated level based on the calibration coefficients of the agent proportional valve. If the flow is less than expected the test fails and **67%** will be stored in the system check error history. If the flow is higher than expected the test fails and **68%** will be stored in the system check error history.	If failed at 61%, 67 or 71%. Replace agent proportional valve and calibrate the Agent flow. Replace Out flow close valve. If failed at 68%, 69% or 79% Calibrate the Agent flow Replace agent proportional valve and calibrate the Agent flow.
80-89	The out flow valve and the O_2 test valve are closed.	Checks the vaporizer one way valve function.	Measures the by-pass flow after 5 seconds. If the flow is more than 100 ml/min this indicate a leak. If the test fails **84%** will be stored in the system check error history.	Replace the Vaporizer (cassette) one way valve.
90-100	The in flow and the out flow and the agent proportional valve are closed. The scavenger valve is opened.	Checks to see if the scavenging valve is opening.	If the cassette pressure sensor not indicate any pressure drop will this indicate that the scavenging valve not had open during the test. If the test fails **95%** will be stored in the system check error history.	Replace scavenging valve.

Fresh Gas Control Unit diagnostics page layout



```
                                                                    9:53

 10000  02 flow                                          Status:
                                                           NO STATUS

  5000 [ml/min]

       0
    Rotate Wheel to change trace      Sensors      Zero    AD    Scaled
    Press Wheel to redisplay menu     Flow         value   value  value    Valve positions:
                                      Flow Contr.                 (l/min)  Flow Controls
    Voltages:                           02:         ---     ---   0.500 ◄    02:           CLOSE
    +12V   +10V   +5V  -15V             N20/Air:    ---     ---   4.612      N20:            ---
       ---    ---    ---    ---         Sum:                      5.112       Safety lim:    ---
    Temperature        oC                                                    Air:          CLOSE
     Sensor 1:          ---           Vaporizer                              Zero:         CLOSE
     Sensor 2:          ---             Bypass:     ---     ---     ---
                                        Cassette:   ---     ---     ---  Vaporizer
    Ratios                              Level:              ---      40    Agent:          ---
     Set:               ---           Pressure                    (mmHg)    Safety lim:    ---
     Measured:          ---             Counter:                    ---    Inflow:       CLOSE
                                        Circuit:                    ---    Outflow:      CLOSE
                                        Cassette:                   ---    Scaveng:      CLOSE
                                                                (100xkPa)  Des fan:        OFF
                                        N20:                        ---    Zero:         CLOSE

                                      EEPROM Storage:               ---
                                                                         FGC exists:        YES
 O2                                                     5%
  l/min      l/min              % in fresh gas
  0.50       4.6                          1.5                    0%
```

Figure 59 **Fresh Gas Control Unit (A-FGC1) diagnostics page. Explanations on next page.**

Table of explanations for the Fresh Gas Control Unit diagnostic page

Voltages

Voltages measured:

+12V (12,7-13,8V) = Operating voltage for valve drivers.

+10V = Operating voltage for pressure sensors.

+5V (4.75-5,25V) = Operating voltage for digital electronics.

-15V (-14-17V) = Operating voltage for analog electronics.

Temperature

Sensor 1: = Temperature of Aladin cassette.

Sensor 2: = Temperature of Aladin cassette.

Ratios

Set: = Calculated Ratio between cassette flow and bypass flow.

Measured: = Ratio between cassette flow and bypass flow.

Sensors

Flow controls*

O_2: = Flow passing the Oxygen flow measurement unit.
N_2O/Air = Flow passing the sidegas flow measurement unit.
Sum: = The sum of the flow at fresh gas outlet. The total flow is the sum of the measured O_2, sidegas and anaesthetic agent flows.

* Flow Contr presents:
Zero value, signal value in AD counts and scaled flow value in l/min. AD value = difference between zero value and scaled value (present sensor values.)

Vaporizer

Bypass: = Flow passing the Bypass flow measurement unit.

Cassette: = Flow passing the Cassette flow measurement unit.

Level: Liquid level.

Pressure

Counter: = Pressure after the O_2 and sidegas flow sensors.

Circuit: = Calculated circuit pressure (fresh gas outlet).

Circuit pressure is the static gauge pressure within the gas piping measured at the vaporizer outlet. It is used for the liquid channel flow compensation.

Circuit pressure is obtained (calculated) by subtracting the vaporizer pressure difference (i.e. the pressure difference across the bypass channel) from the mixer counter pressure.

Cassette: = Cassette pressure.

N_2O: = N_2O gas supply pressure.

EEPROM Storage = Calibration factor stored in the EEPROM.

NOTE: Cursor option on the diagnostic page can be used to see signal in graph form

Status

Messages present times (see Trouble Shooting).

Valve positions

Flow controls

O_2: = Position of O_2 test valve.

N_2O: Position of N_2O proportional valve.

Safety lim: = Not used.

Air = N_2O/Air selector switch.

Zero (1): = Zero valves for O_2 and sidegas flow measurement units.

NOTE: On the connection board in the A-FGC1 are the cable connections marked with Zero1 for the valves.

Vaporizer

Agent: = Position of the Agent proportional valve.

Safety lim: = Calculated maximum limit for the

agent proportional valve.

Inflow = Position of the Cassette inflow close valve.

Outflow: = Position of the Cassette outflow close valve.

Scaveng: Position of Scavenging valve.

Des fan: = Operation of the Fan.

Zero (2): = Zeroing valves for the bypass, cassette flow measurement units and the cassette pressure sensor.

NOTE: On the connection board in the A-FGC1 are the cable connections marked with Zero2 for valves.

FGC exists:

YES = Communication OK.

NO: = No communication with the FGC.

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SPARE PARTS A-FGC1

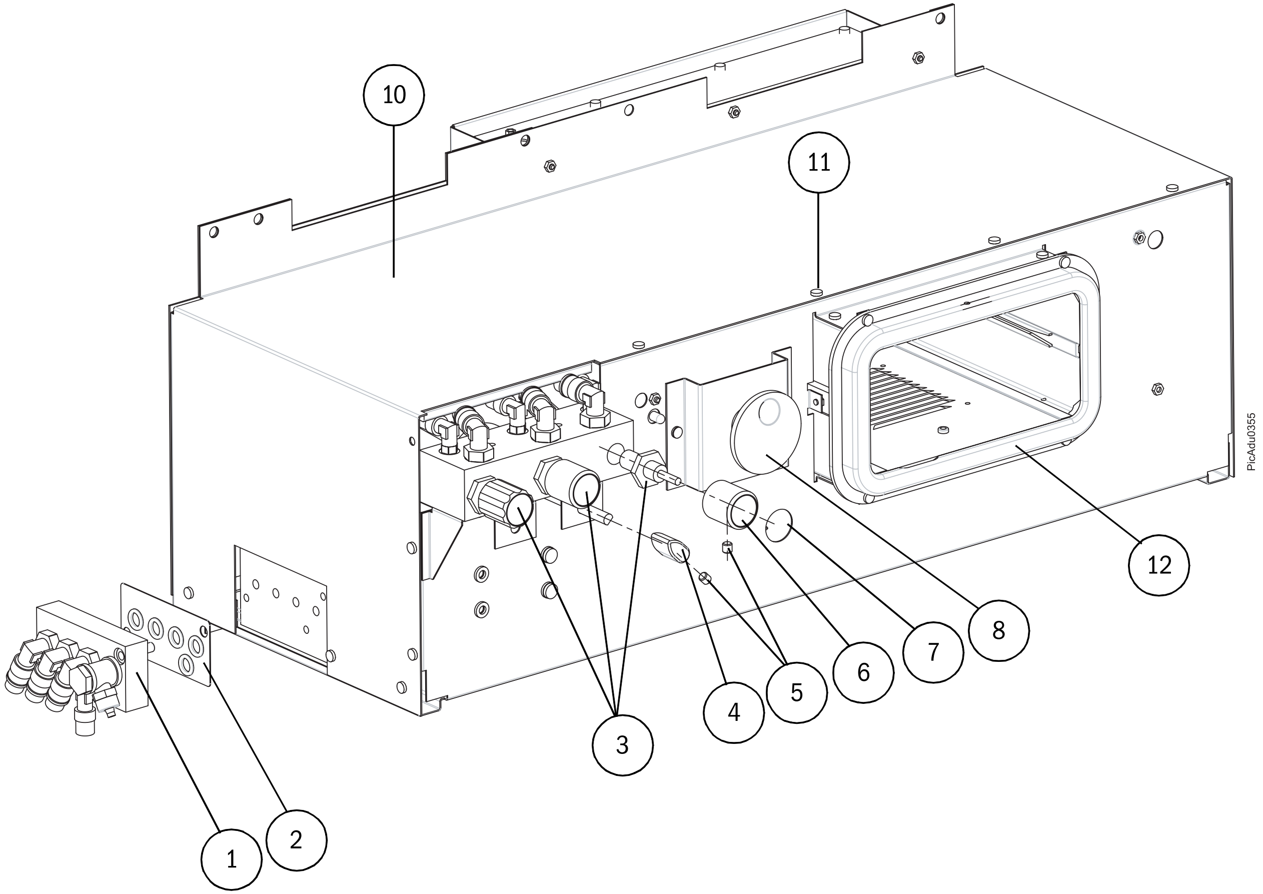
General

Table YES (Y) = To replace the spare part the A-FGC1 should be removed from frame.
Table NO (N)= Spare part can be installed without removing the A-FGC1 from frame.
XX = Dedending where installed.
* = Parts compatible with the AS/3 ADU S/N: 293001-294000, 981001-981110

Fresh Gas Control Unit, A-FGC1

A-FGC-1 front view

Item	Item description	Order No.	Y	N
-	Fresh Gas Control Unit, Exchange unit	A-FGC1-E	X	
-	Fresh Gas Control Unit, New unit	A-FGC1-S	X	
1	A-FGC1 Multiconnector	889751		X
2	Seal Multiconnector	892860		X
3	Needle valve (O_2, Air & N_2O)	755531*	X	
4	N_2O/Air selector knob (without screw)	884433 *		X
5	Screw for item 4 and 6	61956*		X
6	N_2O or Air needle valve knob (without screw and label)	884401*		X
6	N_2O and Air needle valve knob Austria (without screw and label)	885819*		X
6	O_2 needle valve knob (without screw and label)	884402*		X
7	Gas label Blue with text N2O	8500957		X
7	Gas label Yellow with text Air	8500956		X
7	Gas label Green with text O2	8500958		X
7	Gas label white (no text)	884953		X
7	Gas label blue (no text)	884958		X
7	Gas label black/white (no text)	884959		X
7	Gas label brown/blue (no text)	884960		X
7	Gas label Yellow (no text)	884961		X
7	Gas label grey (no text)	884962		X
7	Gas label green (no text)	884963		X
7	Gas label brown (no text)	886281		X
7	Gas label red (no text)	887073		X
8	Agent control wheel (including mounting screw)	8502836	X	
-	Cassette housing O-rings	65371		X
10	Chassis cover	610654700	X	
11	Screw kit for chassis	61921	X	
12	Cassette housing frame	891910	X	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2
1
PicAdu0355

Figure 60 Fresh Gas Control Unit A-FGC1

Spare parts located behind the A-FGC1 electronic cover

Item	Item description	Order No.	Y	N
1	DC/DC power board	896323*		X
2	Fuses F630 mA DC/DC board	511142*		X
3	Fuses F2.5A DC/DC board	511384*		X
4	A-FGC1 software (contact Datex-Ohmeda for latest version available)	XXXXXXX		X
5	EEPROM memory	13972		X
6	A-EV1 CPU board	896513		X
7	Toothed washer	63611		X
8	Chassis screw	61721		X

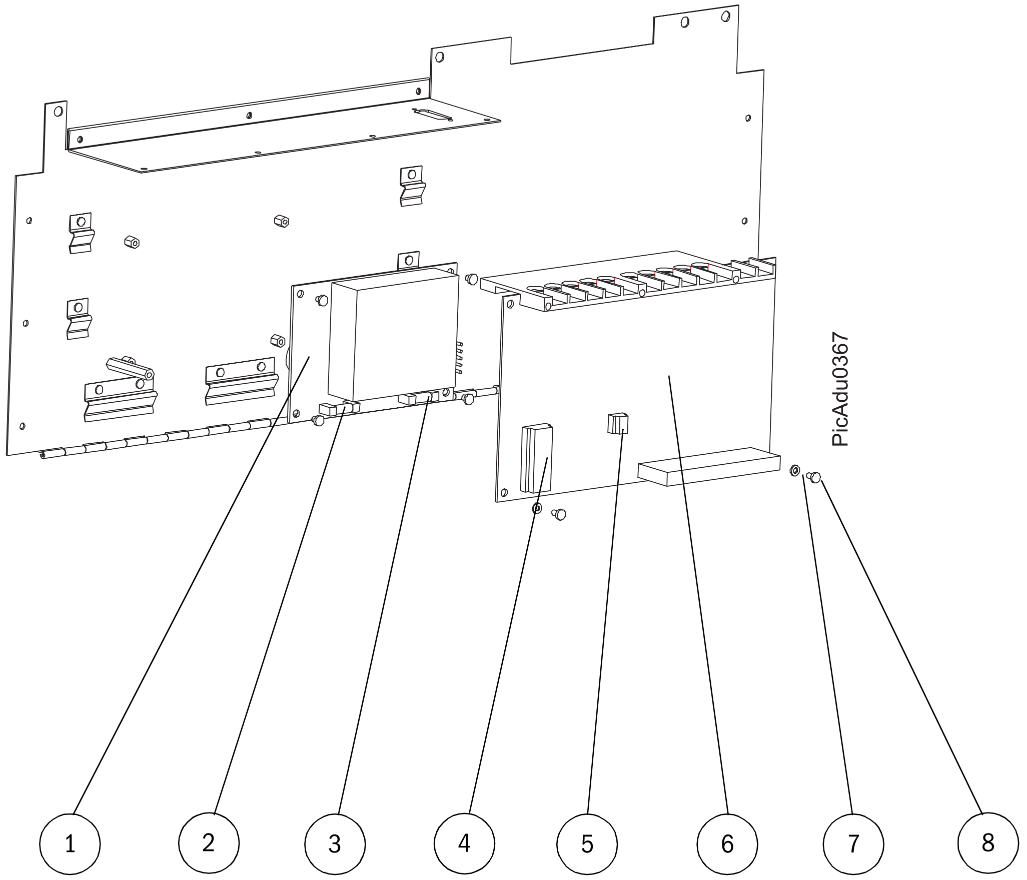


Figure 61 **Parts located behind the A-FGC1 unit**

Item	Item description	Order No.	Y	N
1	Electronic cover	893808		X

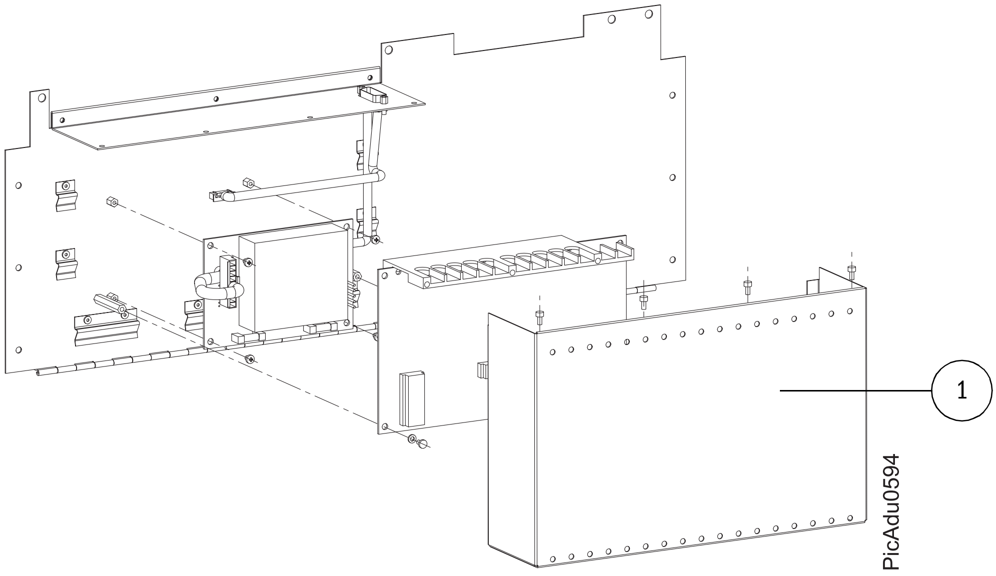


Figure 62 Parts located behind the A-FGC1

Cable

Item	Item description	Order No.	Y	N
X	Cable between electronics and connection board	890180		X

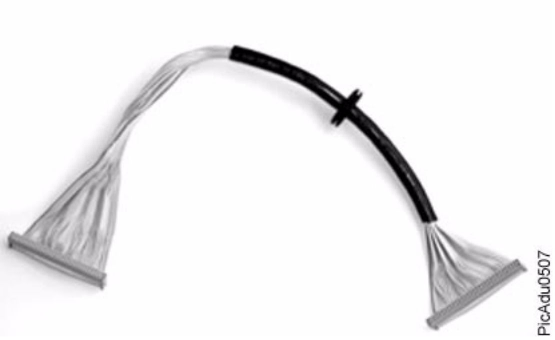
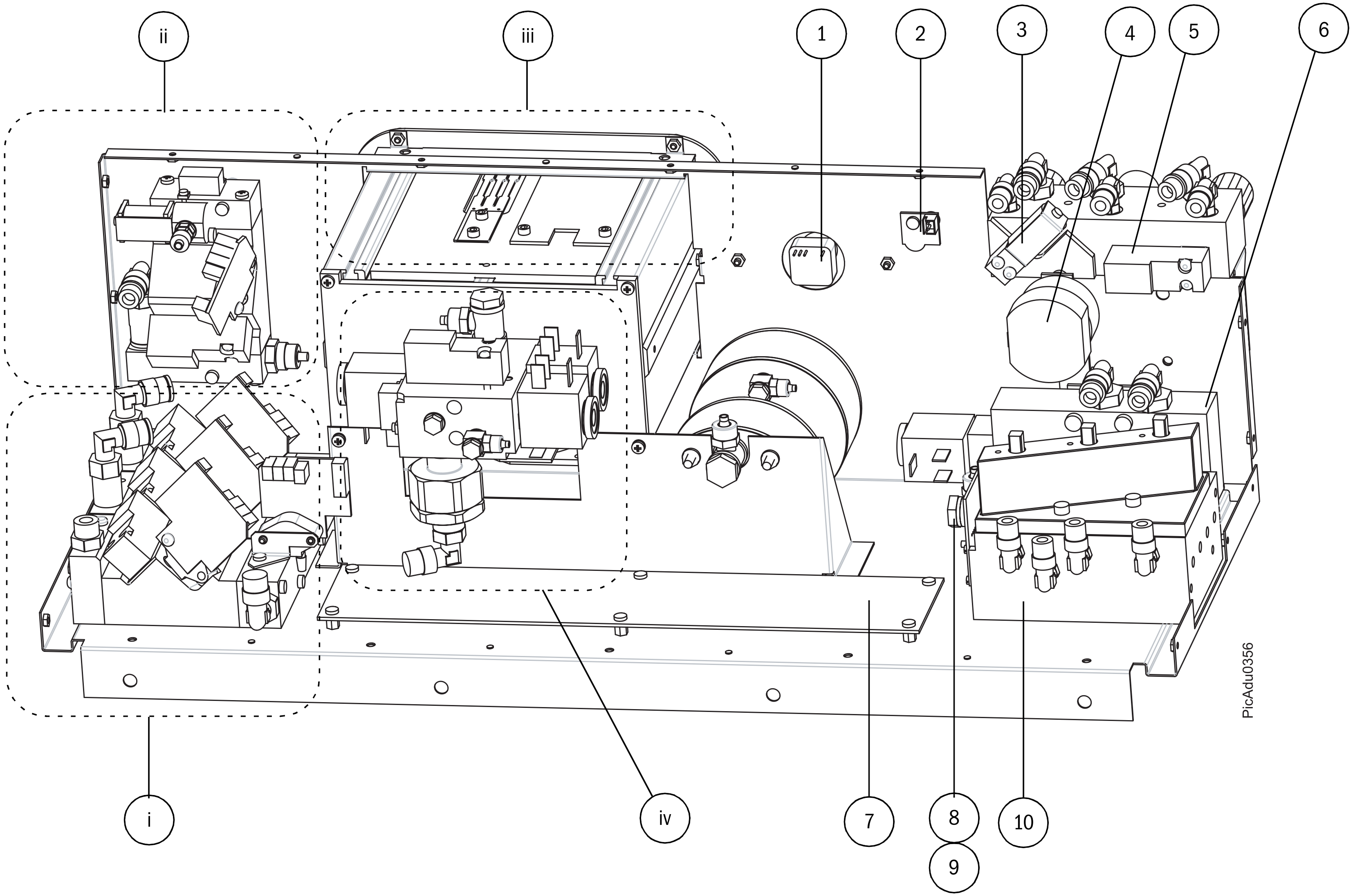


Figure 63 Cable between electronics and connection board

Parts inside the Fresh Gas Control Unit

Item	Item description	Order No.	Y	N
1	Agent control wheel (decoder)	890740	Y	
2	Agent led board	893176		N
3	N_2O proportional valve	890728		N
4	N_2O/Air selection switch (ISO version)	889762	Y	
4	N_2O/Air selection switch (ANSI version)	8500294	Y	
5	O_2 Test valve	890726		N
6	N_2O/Air valve (5/2)	889758	Y	
7	Connection board	890185		N
8	N_2O wall pressure sensor board. (only A-FGC1 modules < S/N 4008800)	890413		N
9	N_2O wall pressure sensor board. (only A-FGC1 modules > S/N 4008800)	898639		N
10	Gas connection unit with Regulators and N_2O wall pressure sensor	889750		N


ii
iii
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PicAdu0356
i
iv
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9
10

Figure 64 **Parts inside the A-FGC1**

Item	Item description	Order No.	Y	N
1	O_2 measuring board	893152	Y	
2	Side gas pressure measuring board	893152	Y	
3	Bypass pressure measurement board	893151	Y	
4	Counter pressure measurement board (O-ring for board 65363)	893153		N
5	Zeroing valve on flow measuring units O_2, bypass and sidegas (O-ring for valve 65377)	890736	Y	

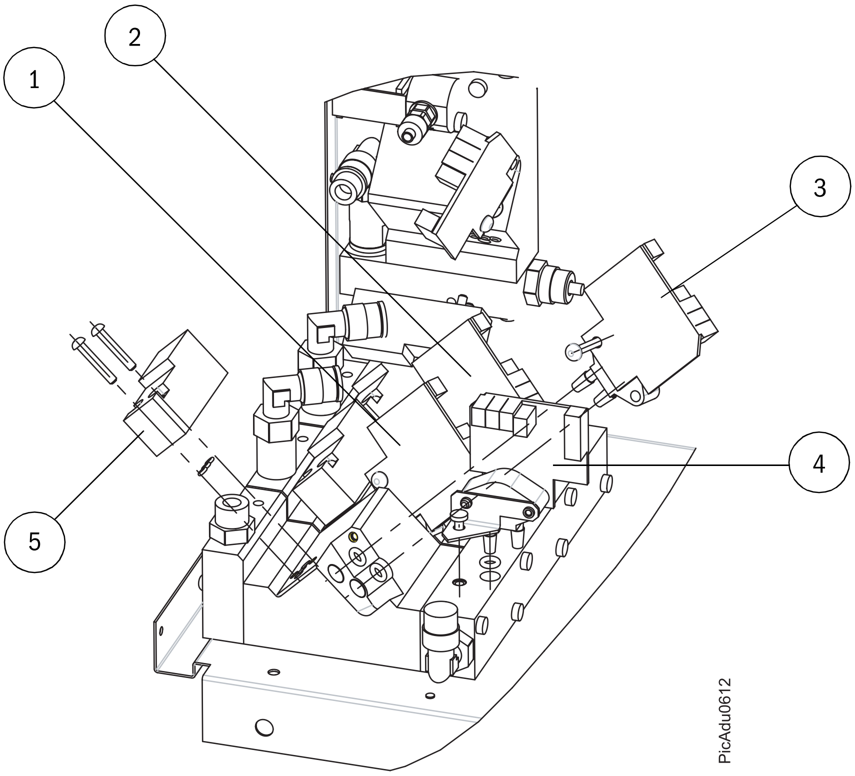


Figure 65 (i) Flow measurement units

Item	Item description	Order No.	Y	N
1	Bypass gas flow measurement unit	890194	Y	
2	Side gas flow measurement unit	890193	Y	
3	O_2 gas flow measurement unit	890193	Y	

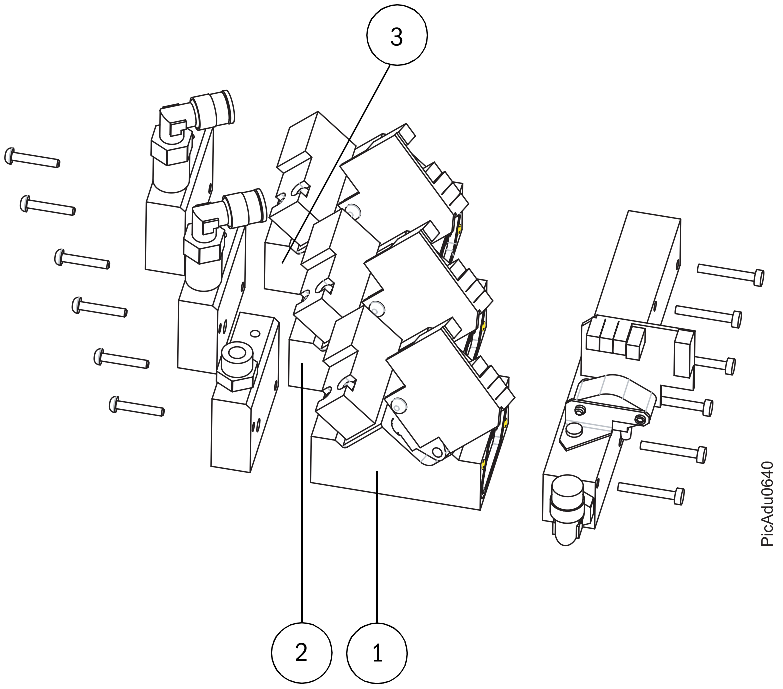


Figure 66 (i) Flow measurement units

Item	Item description	Order No.	Y	N
1	Agent proportional valve	890737	Y	
2	Cassette flow measuring unit (Including items 1-5)	890190		N
3	zeroing valve	892830	Y	
4	Cassette flow measuring board	894814	Y	
5	Vaporiser heating resistor	890282	Y	

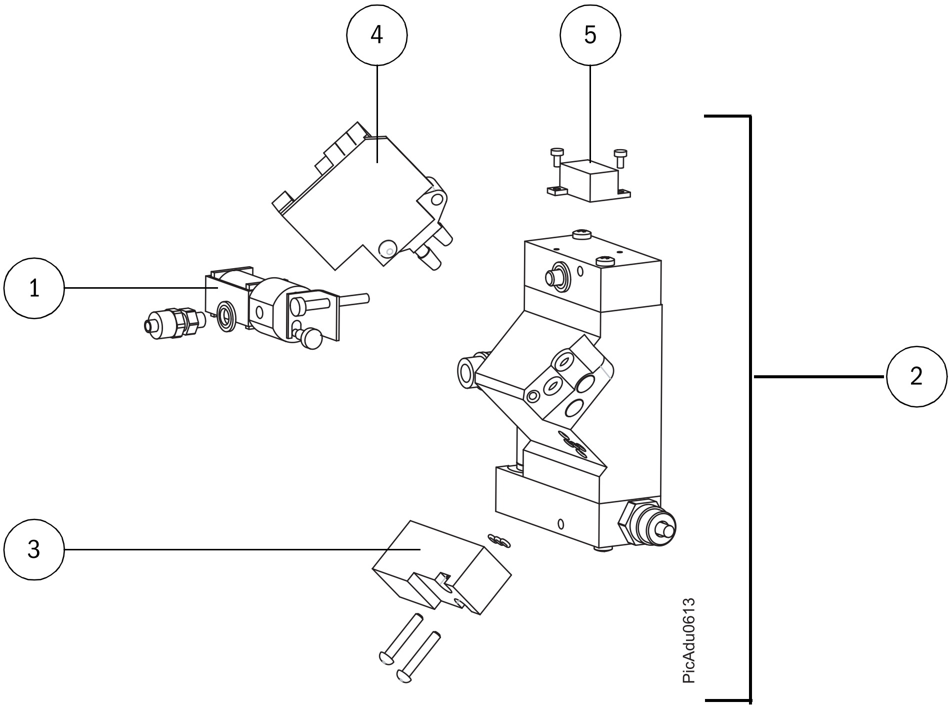


Figure 67 (ii) exploded view

Item	Item description	Order No.	Y	N
1	Piston valve (2pcs)	889509*		X
2	Cassette housing identification board	884118*	Y	
3	Agent Liquid level board	891901	Y	

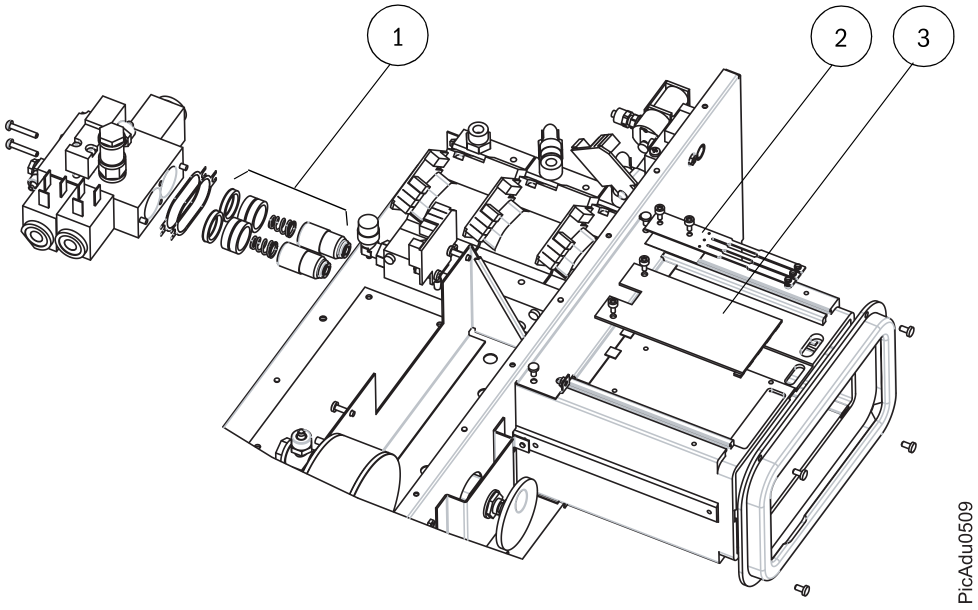


Figure 68 (iii) and (iv)

Item	Item description	Order No.	Y	N
1	Cassette pressure zeroing valve	892830		N
2	Cassette inflow close valve	58559		N
3	Valve block Heating resistor	890282		N
4	Temperature sensor	884320		N
5	Cassette outflow close valve	58559		N
6	Scavenging valve	585590		N
7	Cassette pressure measurement board	8501336		N
8	Cassette one-way valve	8502660		N

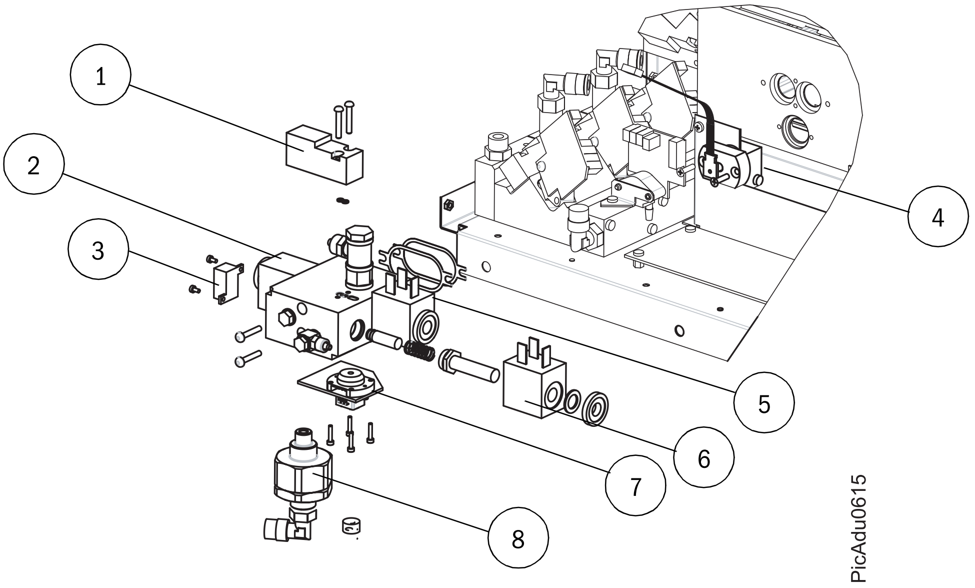


Figure 69 **(iv) Exploded view**

Fan - cassette house

Item	Item description	Order No.	Y	N
47	Fan - cassette house	890727	Y	

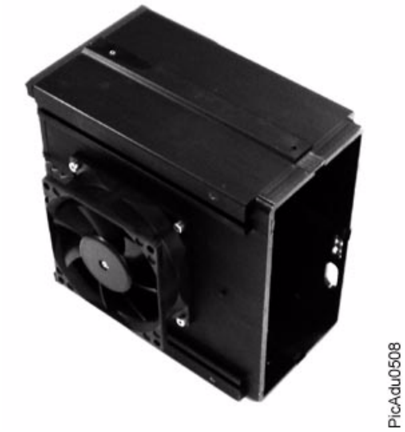
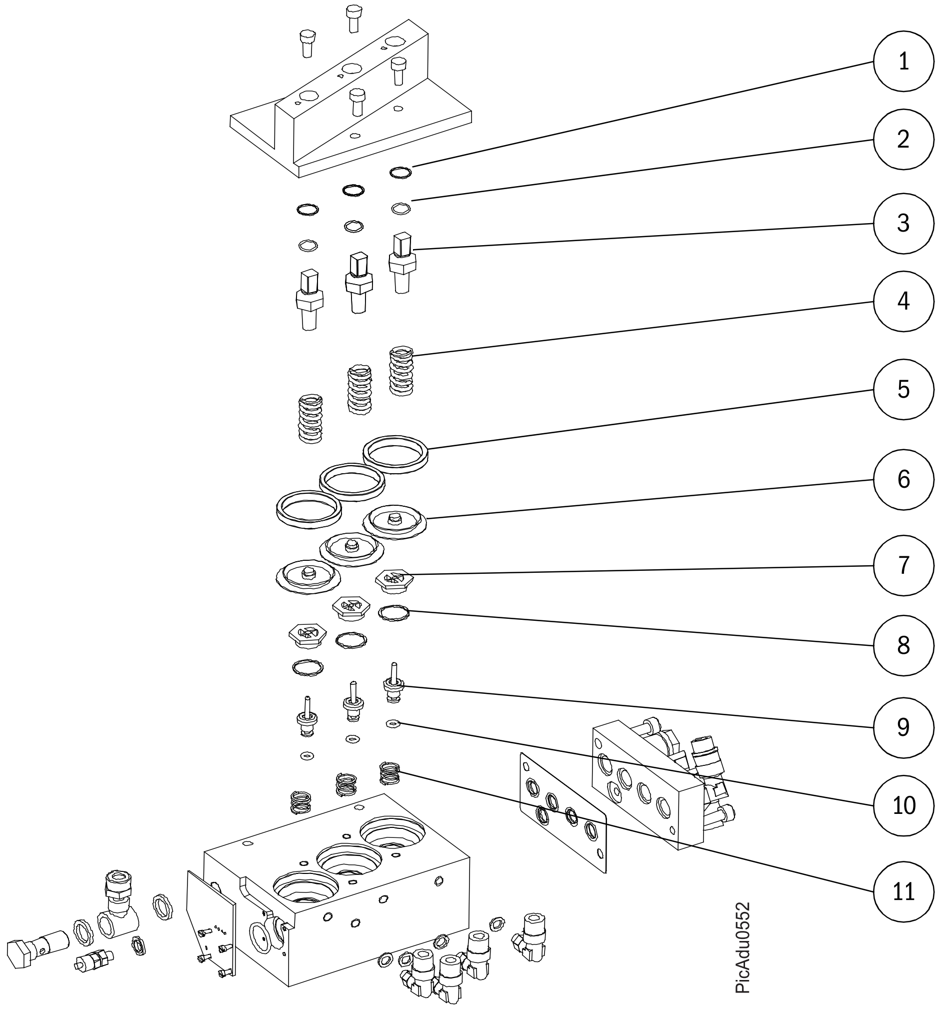


Figure 70 Fan - cassette house

Gas connection unit

Items	Item description	Order No.	Y	N
1-11	**Gas connection unit - Regular repair kit large** **(O_2 or Air or N_2O)**	**888051***		**X**
1	Washer			
2	O-ring			
3	Adjustment screw			
4	Regulator spring			
5	Clamp Ring			
6	Membrane			
7	Valve seat			
8	Seal ring			
9	Valve			
10	O-ring			
11	Regulator spring			
6-10	**Regulator repair kit standard**	**8502225***		**X**
6	Membrane			
7	Valve seat			x
8	Seal ring			x
9	Valve			x
10	O-ring			x


1
2
3
4
5
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11
PicAdu0552

Figure 71 **Gas connection unit**

Tubings (hoses)

Item description	Order No.	Y	N
Hose PA11P40 5/3 BLUE	733482	X	X
Hose PA11P40 5/3 Natural	733483	X	X
Hose PA11P40 6/4 Natural	733472	X	X
Hose PA11 6/4 BLUE	733471	X	X
Hose LDEP 5/3 Red	733483	X	X
Hose LDEP 6/4 Red	733478	X	X
Hose Polythene 8/6 Red	733476	X	X

Connectors and seals

Item	Item description	Order No.	Y	N
1	Rubber seal (fit Banjo screw M8)	646722	Y	
3,4, 6	Fitting tube for plastic tube ID=6mm, thread =1/8 in, Elbow, Degrease treated, Viton O-ring	64678	Y	
2,5,7,11, 10, 9,8	Fitting-tube for plastic tube, ID=5 mm, Thread=M5, elbow, degrease treated, viton O-ring	64689	Y	N
12	Banjo screw M5	61003		X
12	Rubber seal (fit Banjo screw M5)	646723		X
13, 14	Fitting-tube, for plastic tube, id=5 mm, thread=1/8 in, elbow, degrease treated, viton o-ring	64690		N
15	Fitting-tube, for plastic tube, id=6 mm, thread=1/8 in, straight, degrease treated, v iton o-ring	64677	Y	
16, 17	Fitting-tube, for plastic tube, id=6 mm, thread=1/8 in, extended elbow, degrease treated, viton o-ring	646920	Y	N

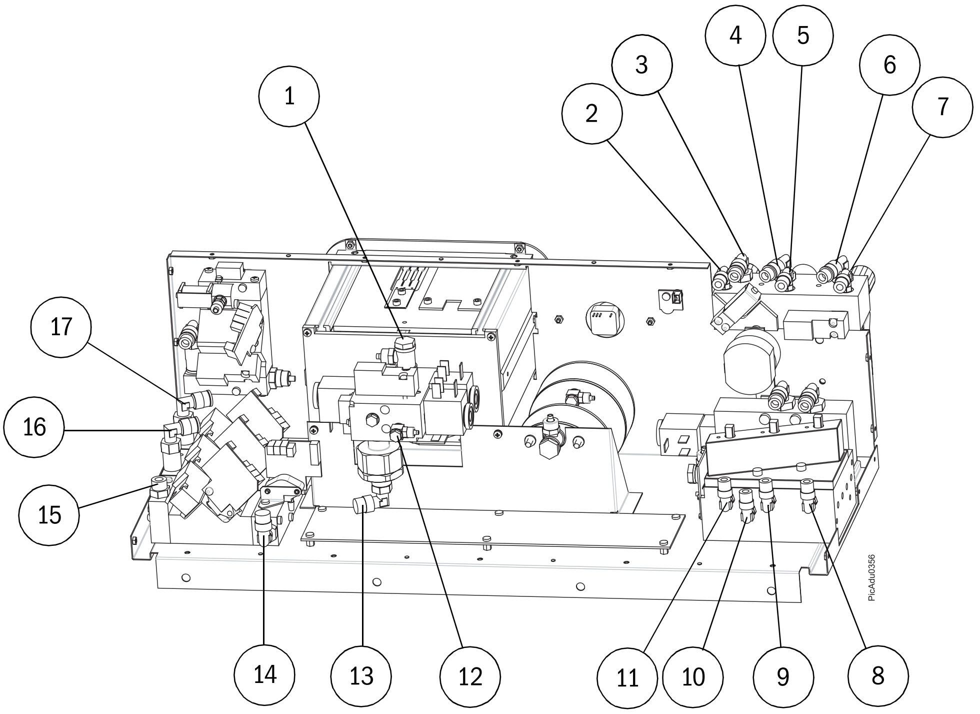


Figure 72 **A-FGC1 connectors and seals**

Aladin cassettes

Cassette with Keyfiller

Item	Item description	Order No.
1	Knob label, English	885958
1	Knob label, French	886612
1	Knob label, German	886611
1	Knob label, Italian	888427
1	Knob label, Dutch	887442
1	Knob label, Swedish	887443
1	Knob label, Spanish	889257
2	Name label, see Aladin Cassette/Name labels	
3	Cassette handle (Common to all cassettes)	885912

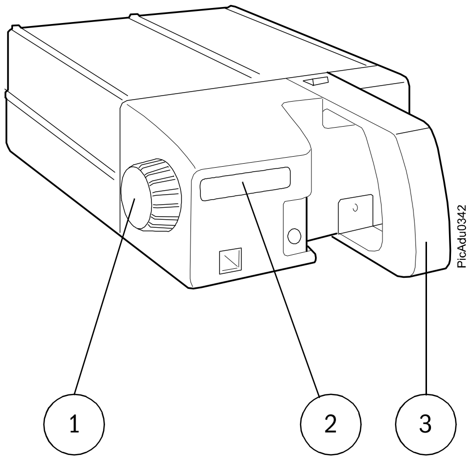


Figure 73 Aladin cassette

Aladin cassette with Keyfiller

Keyfiller gasket kit

Item	Item description	Order No.
-	Key filler Gasket	8501299
1	Frame	-
2	Filler seal	-
3	Screw (4 pcs)	-

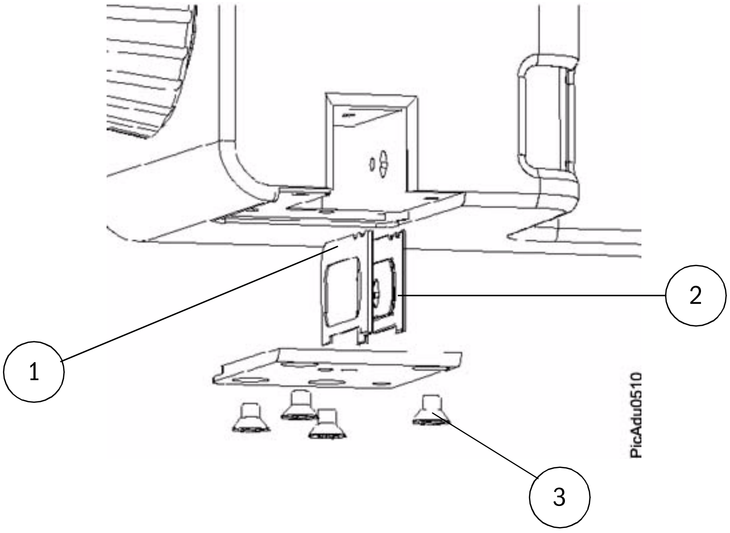
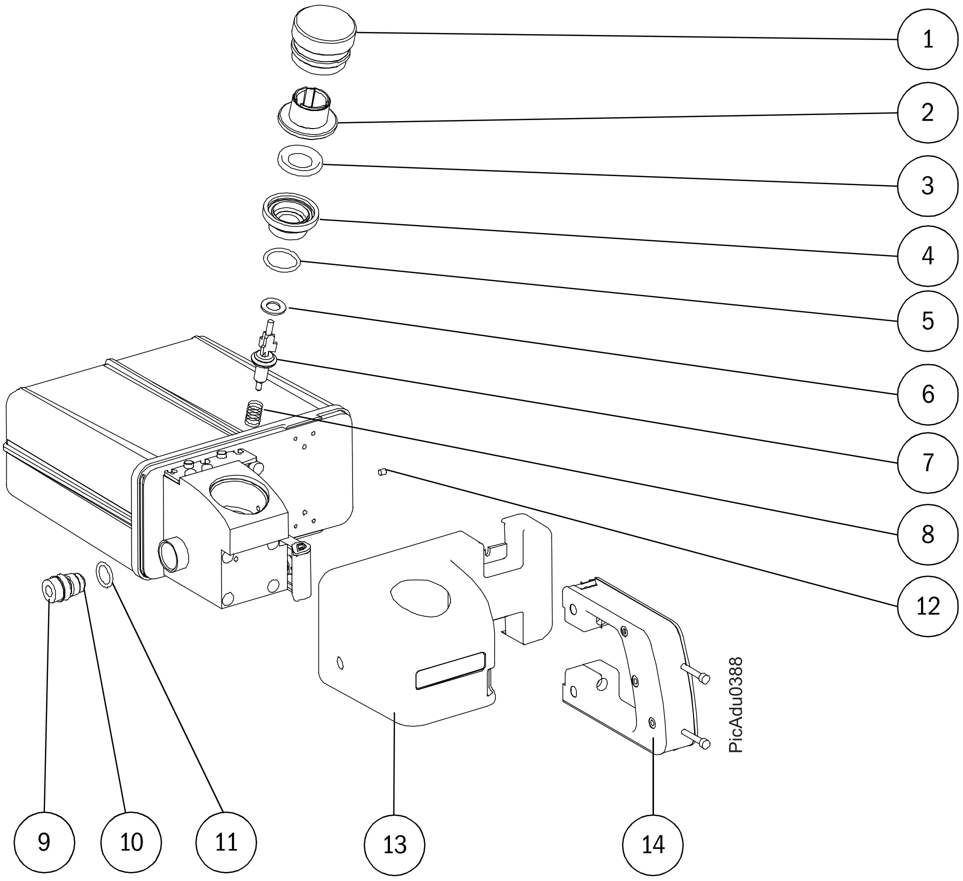


Figure 74 Aladin Keyfiller gasket kit

Aladin cassette with Quik Fil^{TM}

Item	Item description	Order No.
-	Tool for disassembly/Assembly	8500168
1	Cap	889674
2	Housing sleeve	889672
3	Spout sealing	889673
4	Housing bottom	889665
5	O-ring	65386
6	Plunger sealing	889668
7	Plunger	889667
8	Plunger spring	64238
9	Emptying screw	619263
10	Emptying screw	889669
11	O-ring	65638
12	Locking screw (1.5 mm)	619584
13	Sevoflurane mask	890422
14	Cassette handle (Common to all cassettes)	885912



Aladin cassette with Desflurane Filling System

Item	Item description	Order No.
-	Cassette labels, see Aladin Cassette/Name labels	
73	Cassette handle (Common to all cassettes)	885912

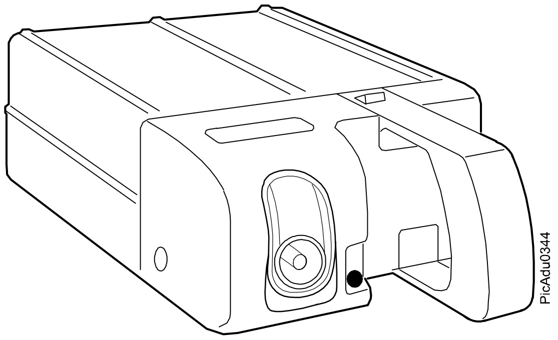


Figure 75 Aladin cassette with Desflurane Filling System

Aladin name labels

Item description	Order No.
Name label, Halothane	885959
Name label, Halothan	887910
Name label, Halothaan	887914
Name label, Alotano	888429
Name label, Sevoflurane	885962
Name label, Sevofluran	887911
Name label, Sevofluraan	887915
Name label, Sevoflurano	888434
Name label, Isoflurane	885963
Name label, Isofluran	887912
Name label, Isofluraan	887916
Name label, Isoflurano	888433
Name label, Enflurane	885964
Name label, Enfluran	887913
Name label, Enfluraan	887917
Name label, Enflurano	888428
Name label, DESFLURANE	890420
Name label, DESFLURANO	894764
Name label, DESFLURAAN	894765
Name label, DESFLURAN	894038

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TECHNICAL DESCRIPTION A-EV1

General

The ADU Electronic Ventilator module (A-EV1) is an electronically controlled, time-cycled flow generator. The ventilator delivers tidal volumes compensated for the actual inspiratory fresh gas flow and real measured breathing circuit compliance.

The A-EV1 includes:

- The control unit

The ventilator control unit consists of hardware, electronics and software to control mechanical ventilation and to monitor patient pressure.

- The bellows unit

The ventilator bellows unit drives the breathing gas to the patient. Bellows unit also connects pressure sensing lines to the patient circuit.

- The user interface

The control parameters are set with the main display and keyboard.

Main ventilation modes

The ADU has two main ventilation modes; Auto or Manual. The mode selection is done by turning the Auto/Man. switch, located on the bellows block, to Auto or Man. position.

Auto position turns the ventilator on and simultaneously routes the gases in the bellows to the patient. The ventilator may work in three Sub-modes.

In Man. position the user routes the gases to the patient manually, by means of a reservoir bag.

Auto mode

In Auto mode, the ventilator unit ventilates the patient.

Three different ventilation sub-modes may be chosen by the user:

- VCV = Volume Controlled (TV, MV)
- SIMV = Synchronized Intermittent Mandatory Ventilation
- PCV = Pressure Controlled Ventilation

See the User’s Reference Manual for detailed description of the modes.

The APL valve is not operating in Auto mode.

Manual mode

In Manual mode the operator ventilates the patient with a bag or the patient breathes spontaneously.

In Manual mode are the overflow valve and bellows not used.

The maximum circuit pressure is controlled by an Airway Pressure Limiting valve (APL). The valve is located beside the Auto/Man. switch. When the pressure rises above the pre-set level, the APL valve opens and gas bleeds to the scavenging system. When the patient breathes spontaneously, the resistance of the APL valve is 1.5 cmH_2O when the valve is set into minimum position.

Connections of the Electronic Ventilator module (A-EV1)

The connections of the module comprises pneumatic, mechanical and electrical connections.

- The mechanical connection is between the frame and the module.

- The electrical connection is between the central mains electronics and the module, and between the ventilator module and the bellows unit.
- The pneumatic connection is between the frame, the bellows block and the module.

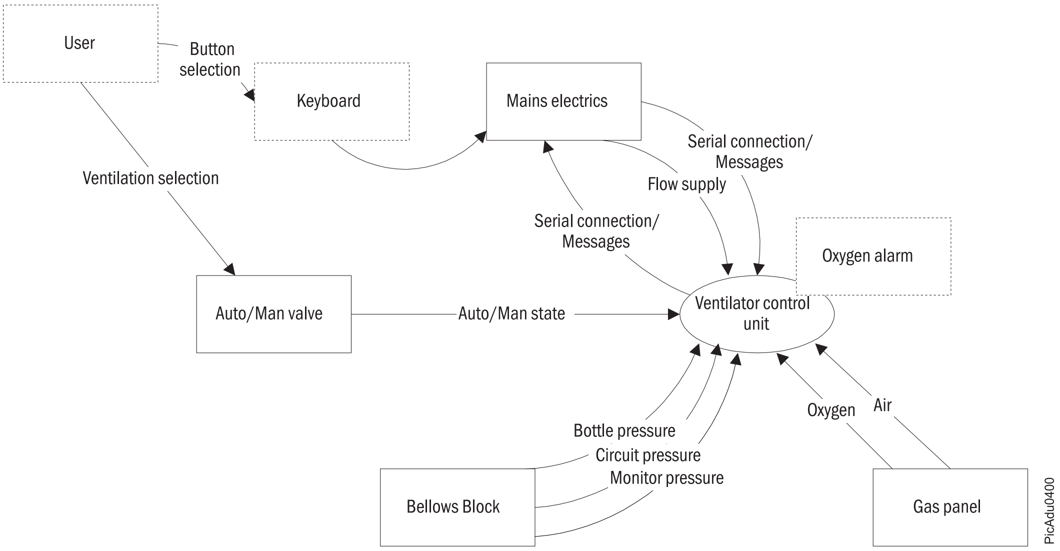

User
Button selection
Keyboard
Mains electrics
Serial connection/ Messages
Flow supply
Ventilation selection
Serial connection/ Messages
Oxygen alarm
Auto/Man valve
Auto/Man state
Ventilator control unit
Oxygen
Air
Bottle pressure
Circuit pressure
Monitor pressure
Bellows Block
Gas panel
PicAdu0400

Figure 1 **Connections of the A-EV1**

Electrical connections

The device is connected electronically with the Central Main Electronics. This connection feeds the power to the module and has communication capabilities.

One connector is used and the device has its own fuses.

The second electronic connection is between the Bellows Block and the Auto/Man. switch device.

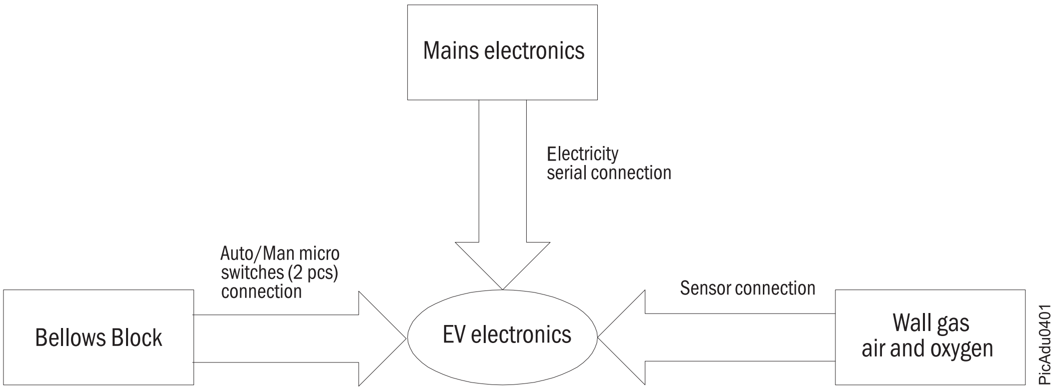

Mains electronics
Electricity serial connection
Auto/Man micro switches (2 pcs) connection
Sensor connection
Bellows Block
EV electronics
Wall gas air and oxygen
PicAdu0401

Figure 2 **The A-EV1 Electrical Connection**

Pneumatic connections

The module is supplied with pressurized air and oxygen.

The following measurement connections take place in the bellows block unit:

- Patient circuit pressure.
- Monitored pressure in the patient circuit.
- The drive gas pressure in the bellows chamber.

Other ventilator pneumatic connections:

- Driving gas tube for the bellows block
- Wall oxygen
- Wall air

The module measures both oxygen and air supply pressure inside the device. Measurement information is also sent and used by other devices.

Mechanical connections

The module will be fixed to the frame of the ADU. Installation is done on the rear side of the unit. The gases are connected on the right hand side, seen from behind. Connection unit is of manifold-type and may be disconnected from the left side.

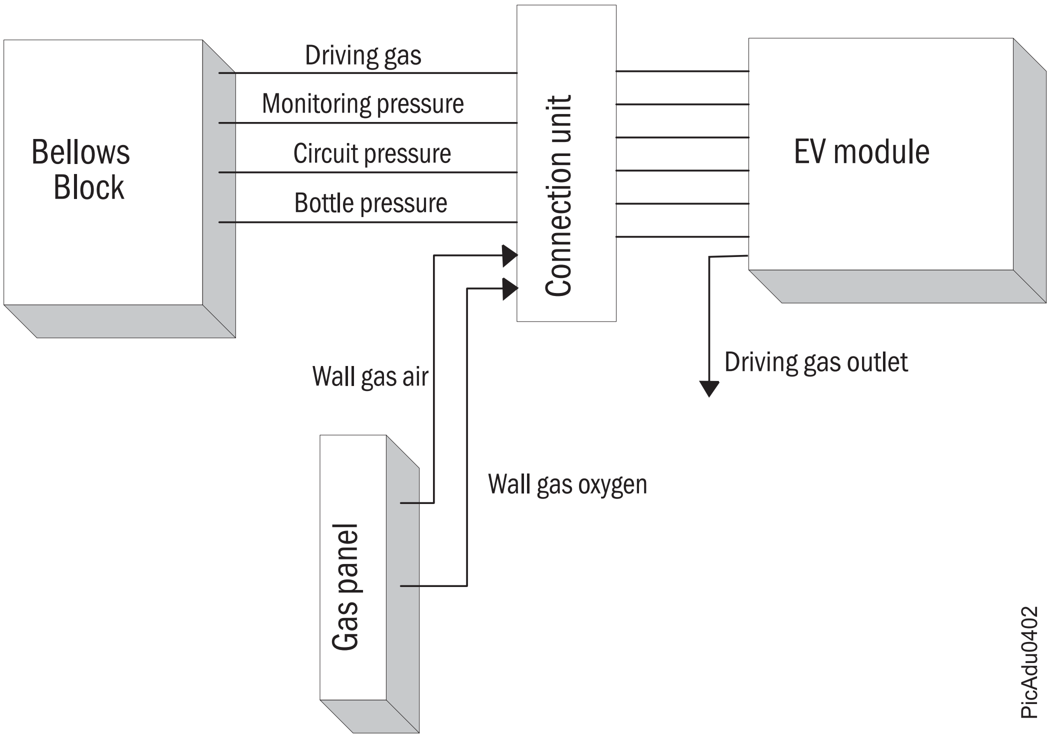

Bellows Block
Driving gas
Monitoring pressure
Circuit pressure
Bottle pressure
Connection unit
EV module
Driving gas outlet
Wall gas air
Wall gas oxygen
Gas panel
PicAdu0402

Figure 3 The A-EV1 mechanical connection

A-EV1 functional description

Drive gas selection

The A-EV1 is supplied with pressurized air and oxygen. The gases are filtered in the wall gas unit and the two one-way valves prevents cross connection

One of the supply gases has to be selected as the primary drive gas for the ventilator, which may be done on the ***Installation*** menu.

Both the oxygen and air supply pressures are measured electronically at the inlet of the ventilator module and if the ventilator primary supply pressure falls below 2.5 x 100 kPa, the primary valve (oxygen or air) will close and the secondary valve open automatically to let the secondary drive gas supply the pressure thus never leaving the ventilator without drive gas.

The air and oxygen solenoid valves are controlled by the values of the pressure sensors.

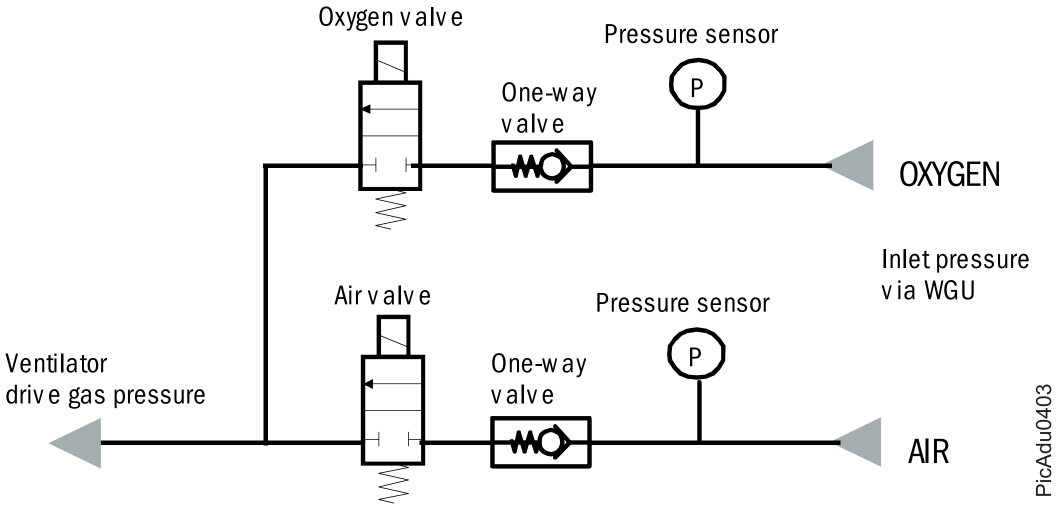

Oxygen valve
Pressure sensor
One-way valve
P
OXYGEN
Inlet pressure via WGU
Air valve
Pressure sensor
Ventilator drive gas pressure
One-way valve
P
AIR
PicAdu0403

Figure 4 **The A-EV1 Drive Gas Selection**

Inlet pressure stabilizing

The ventilator drive gas pressure is preset to 2.7 x 100 kPa on the inlet pressure regulator.

To attain an even and accurate delivery at large volumes and high flow rates, a pressure reservoir has been inserted after the inlet pressure regulator.

The status of the inlet pressure regulator can be measured and mechanically adjusted from the rear of the module (see the *“Ventilator calibration chapter*”).

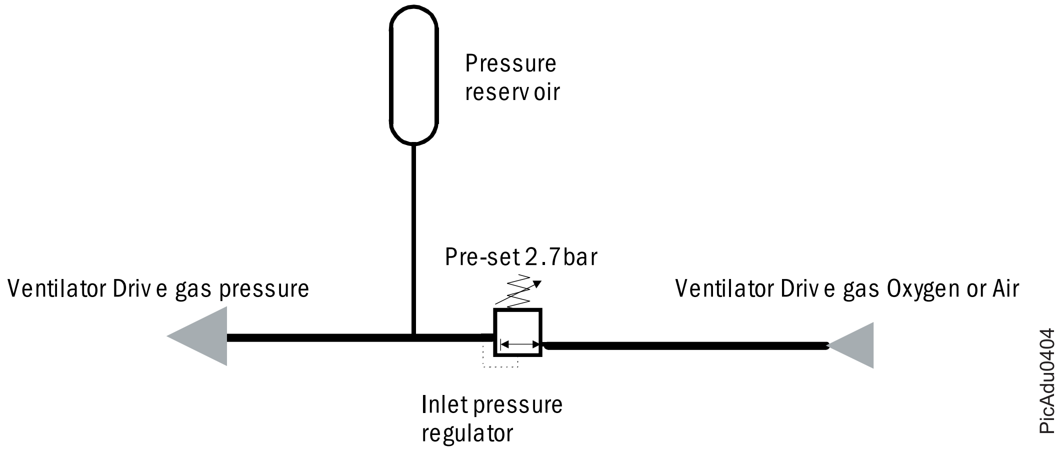

Pressure reservoir
Pre-set 2.7bar
Ventilator Drive gas pressure
Ventilator Drive gas Oxygen or Air
Inlet pressure regulator
PicAdu0404

Figure 5 **A-EV1 Inlet Pressure Stabilization**

Inspiration

Volume controlled ventilation

During the inspiration phase, the inspiration valve opens proportionally to its supplied voltage and the PEEP and expiration valves are held closed. The support flow from the Pilot pressure regulator, will pass the Pilot valves to hold the PEEP and EXP. valves closed during the inspiration phase.

The drive gas flows into the bellows block closing the overflow valve and pressing the gas inside the bellows down thus emptying it and forcing the gas inside to flow to the patient circuit. The flow going through the flow measuring unit is integrated with time. The result of the integration is the tidal volume.

When the desired tidal volume has been delivered, the inspiration ends. If the preset inspiration time is reached before the entire tidal volume is delivered, the inspiration is halted and a message to the User is displayed.

During the Pause phase that follows upon the delivery of the tidal volume, the inspiration, PEEP and expiration valves are kept closed. The expiration phase starts when the PEEP and expiration valves are opened.

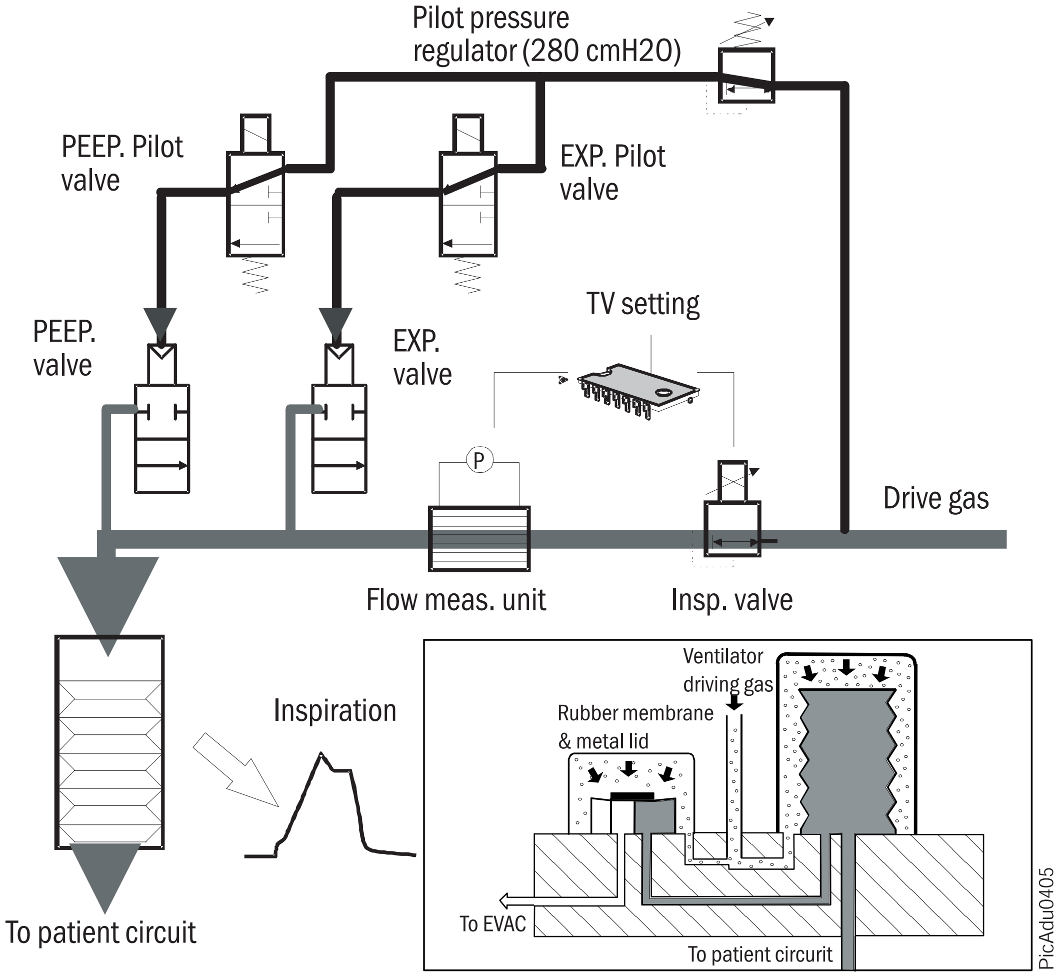

Pilot pressure regulator (280 cmH2O)
PEEP. Pilot valve
EXP. Pilot valve
TV setting
PEEP. valve
EXP. valve
P
Drive gas
Flow meas. unit
Insp. valve
Inspiration
Ventilator driving gas
Rubber membrane & metal lid
To EVAC
To patient circuit
To patient circuit
PicAdu0405

Figure 6 The inspiration gas flow through the Bellows Block

Pressure controlled ventilation

During the inspiration phase, the inspiration valve opens proportionally to its supplied voltage and the expiration valve is closed. The PEEP pilot valve acts as resistance for the gas flowing from the PEEP proportional valve thus creating a pressure on the PEEP valve membrane. The pressure is controlled by the PEEP proportional valve which is set to a value corresponding to the set pressure level.

The gas flow from the inspiration valve is set to a value which gives the required rise time (slow/medium/fast), forces the bellows down thus emptying it into to the patient circuit at the set pressure. The patient pressure sensor is the feed back element.

In the pressure controlled mode there is no pause and the inspiration valve flow is constant during the whole inspiration time. If the set pressure level cannot be reached, a message to the user is displayed.

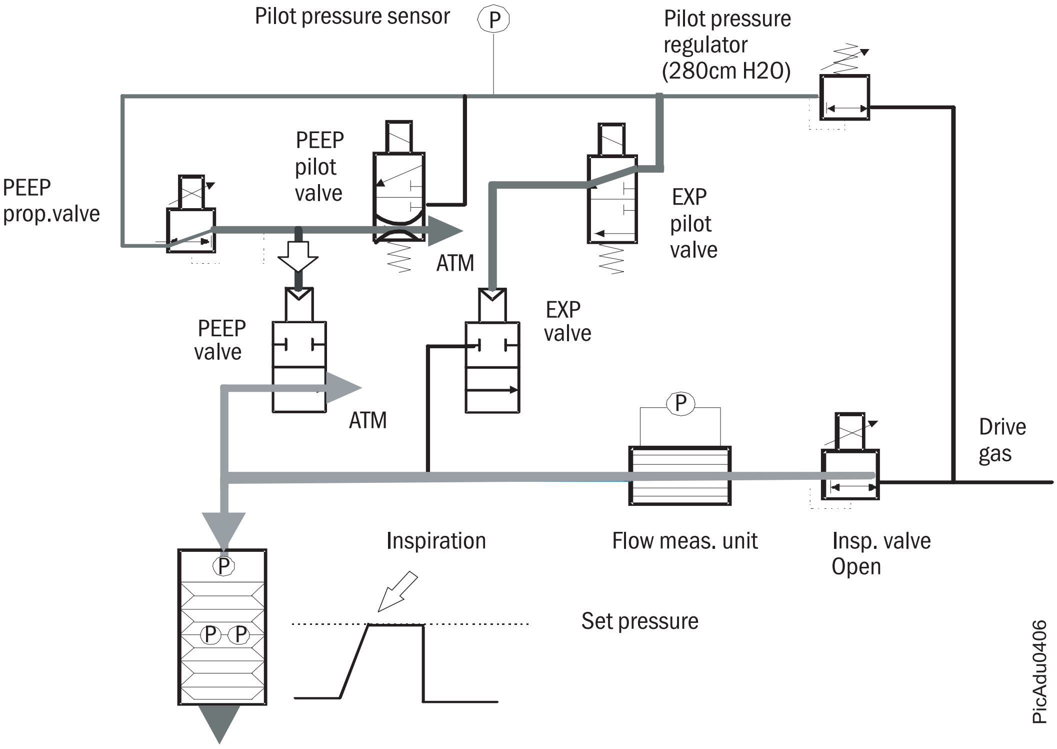

Pilot pressure sensor
P
Pilot pressure
regulator
(280cm H2O)
PEEP
pilot
valve
PEEP
prop.valve
EXP
pilot
valve
ATM
EXP
valve
PEEP
valve
ATM
P
Drive
gas
Inspiration
Flow meas. unit
Insp. valve
Open
P
P P
Set pressure
PicAdu0406

Figure 7 **Pressure controlled ventilation**

Expiration (without PEEP)

During the expiration the inspiration valve is closed and the Expiration and PEEP pilot valves change their positions (closing) and release the pressure on the EXP. and PEEP valves. The pressure inside the bellows chamber is released into the atmosphere.

The patient expires gas into the bellows.

When the bellows reaches its top position, extra gas is bled to the scavenging system through an overflow valve. The overflow valve needs about 2 to 3 cmH_2O of overpressure in the patient circuit, to open.

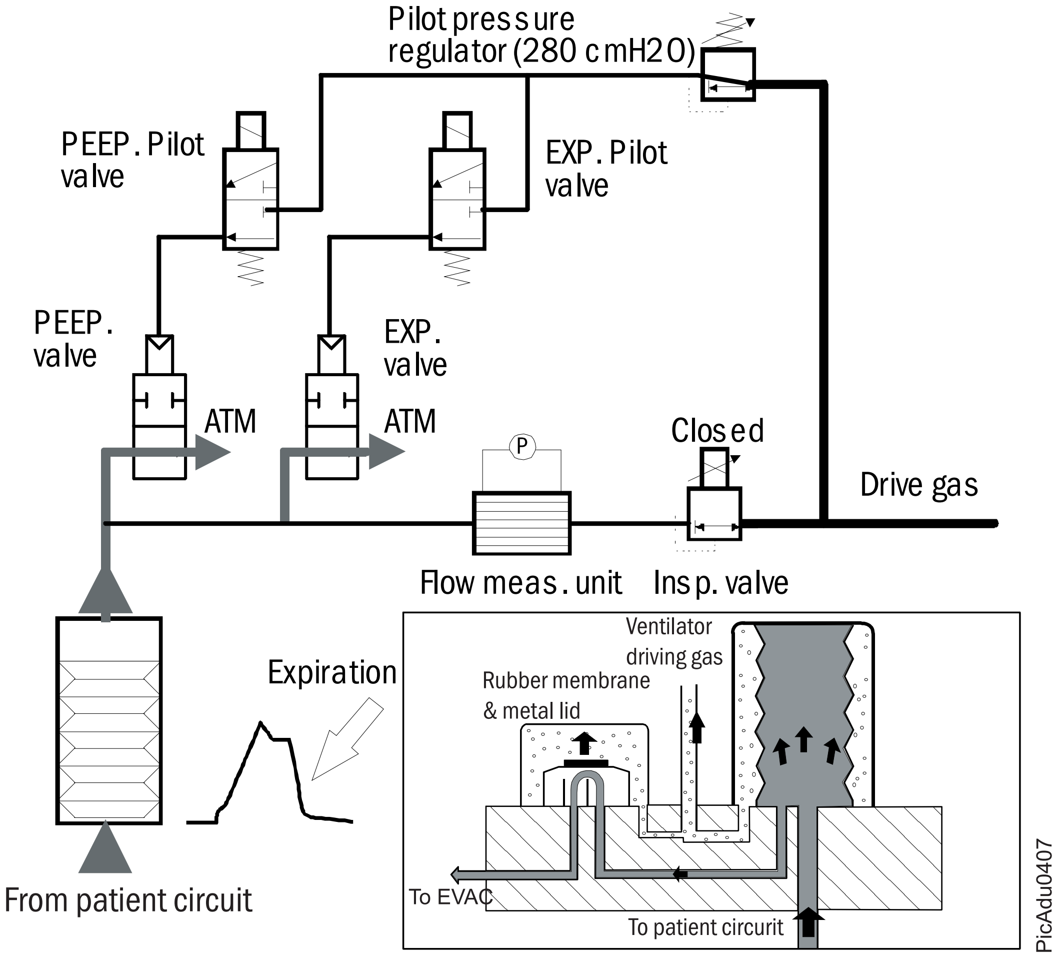

Pilot pressure regulator (280 cmH2O)
PEEP. Pilot valve
EXP. Pilot valve
PEEP. valve
EXP. valve
ATM
ATM
P
Closed
Drive gas
Flow meas. unit
Insp. valve
Expiration
Ventilator driving gas
Rubber membrane & metal lid
From patient circuit
To EVAC
To patient circuit
PicAdu0407

Figure 8 The expiration gas flow through the Bellows Block

PEEP (Positive End Expiratory Pressure)

The preset PEEP pressure is reached in the expiration phase:

The PEEP mechanism consist of a PEEP proportional valve, a PEEP pilot valve and a PEEP valve. The PEEP pilot valve acts as a pneumatic resistance.

During the PEEP phase the inspiration valve is open and delivers a constant 10 l/min. flow to the bellows chamber in order to prevent a patient circuit pressure drop when the bellows reaches its top position. This flow is bled through the PEEP valve. The flow is controlled by the PEEP proportional valve which opens proportionally to its supplied voltage.

The PEEP prop. valve position is updated each ventilation cycle.

The circuit pressure sensor(s) are used as feedback parameter to controlling the PEEP prop. Valve

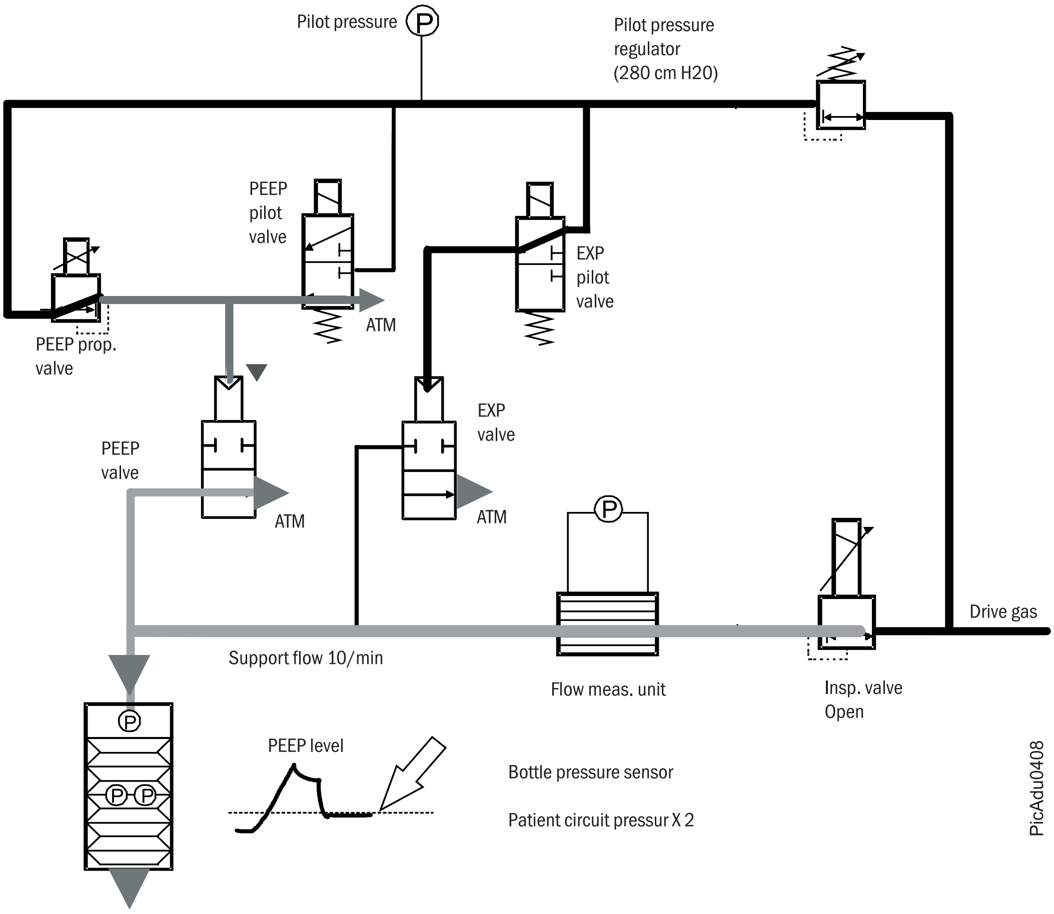

Pilot pressure
P
Pilot pressure regulator (280 cm H20)
PEEP pilot valve
EXP pilot valve
ATM
PEEP prop. valve
PEEP valve
EXP valve
ATM
ATM
P
Drive gas
Support flow 10/min
Flow meas. unit
Insp. valve Open
P
P P
PEEP level
Bottle pressure sensor
Patient circuit pressur X 2
PicAdu0408

Figure 9 **PEEP; Positive End Expiratory Pressure**

Reaching the P_{max} release pressure

When the patient circuit pressure reaches a preset P_{max} release level, the ventilator switches to expiration phase. The inspiration phase and tidal volume delivery are thus interrupted.

Measured parameters

Patient circuit pressures

The patient circuit pressure is measured at the point where the patient circuit is connected to the bellows block. The pressure sensors are doubled for patient safety reasons.

The sensor(s) is used for:

- Ventilator controls
- Alarms and pressure curve

Patient circuit pressure are presented on display. The measurement is available in both Auto and Manual modes.

- The ”P_{peak}” pressure is the peak value in Auto and Manual modes during each breathing cycle
- The ”P_{plat}” is the current pressure value when the expiration starts (Only Auto mode)
- The “P_{min}” is the minimum pressure during a ventilation cycle. (Only in Auto mode)
- The End Expiratory Pressure (”P_{peep}”) is the current pressure when the inspiration starts. (only in Auto mode)

The ventilator will go to safe state and send the message pressure compare error to main SW if the differences between the Monitor and Circuit pressures are outside allowed limits.

- Difference > 6.5 cmH_2O for pressures over 55 cmH_2O
- Difference > 5.5 cmH_2O for pressures over 25 cmH_2O
- Difference > 4.0 cmH_2O otherwise.

Bellows chamber pressure sensor

The bottle pressure sensor is used for:

- Cutting the inspiration if bellows reach the bottom
- Measure pilot pressure during ventilator self test or manually by service diagnostics
- Initiate the alarm Fill Bellows. This is done by comparing the patient pressure with the chamber pressure value. In principal - if the chamber pressure is higher that the patient pressure, the Inspiration interrupt and alarm are initiated. The table below describes the triggering limits for the alarm Fill Bellows.

Patient peak pressure	**Allowed pressure difference (chamber pressure – patient pressure)**
lower than 5.5 cmH_2O	difference < 0.5 cmH_2O
lower than 15 cmH_2O	difference < (peak pressure – 5.0)
otherwise	difference < 10 cmH_2O

Gas consumption

In volume controlled mode the ventilator´s gas consumption is roughly the same as the patient minute volume plus the waste fresh gas flow during expiration.

In PCV mode the ventilator will have higher gas consumption depending of set pressure, IE ratio and flow.

As the compressed volume of the circuit is added to the volume delivered by the ventilator it should be included in the gas consumption. E.g. when the compliance of circuit is 4 ml/cmH_2O and the circuit pressure is 15 cmH_2O, the lost volume for each inspiration is 60 ml. If the ventilation rate is 12, the extra gas consumption is 720 ml/min.

The PEEP function increases the gas consumption with the amount of the support flow. The required support flow is about 10 l/min. As the consumption only increases during the expiration, it is dependent of the I:E ratio setting.

Measuring sensors

The sensors are pressure sensors.

The chart below shows the sensors and their zeroing functions.

Sensors and measuring	**Name on diagnostic page**	**Measuring range**	**Zeroing**
Patient circuit	Circuit	-40 - 100 cmH_2O	zeroing valve 2 (zero phase 1 or 2)
Patient circuit (monitoring)	Monitor	-40 - 100 cmH_2O	zeroing valve 1 (zero phase 1 or 2)

Sensors and measuring	**Name on diagnostic page**	**Measuring range**	**Zeroing**
Bottle pressure * (Pilot valve pressure)	Bottle MUX	-40 - 100 cmH_2O	zeroing valve (zero phase 1 or 2)
Flow measuring	Flow	6 - 100 l/min.	zeroing valve (zero phase 1 or 2)
Wall pressure oxygen	O_2	0 - 8 bar	no zeroing
Wall pressure air	Air	0 - 8 bar	no zeroing

The pressure sensors and their zeroing valves are located in the ventilator module. The diagram that follows shows their pneumatic connections

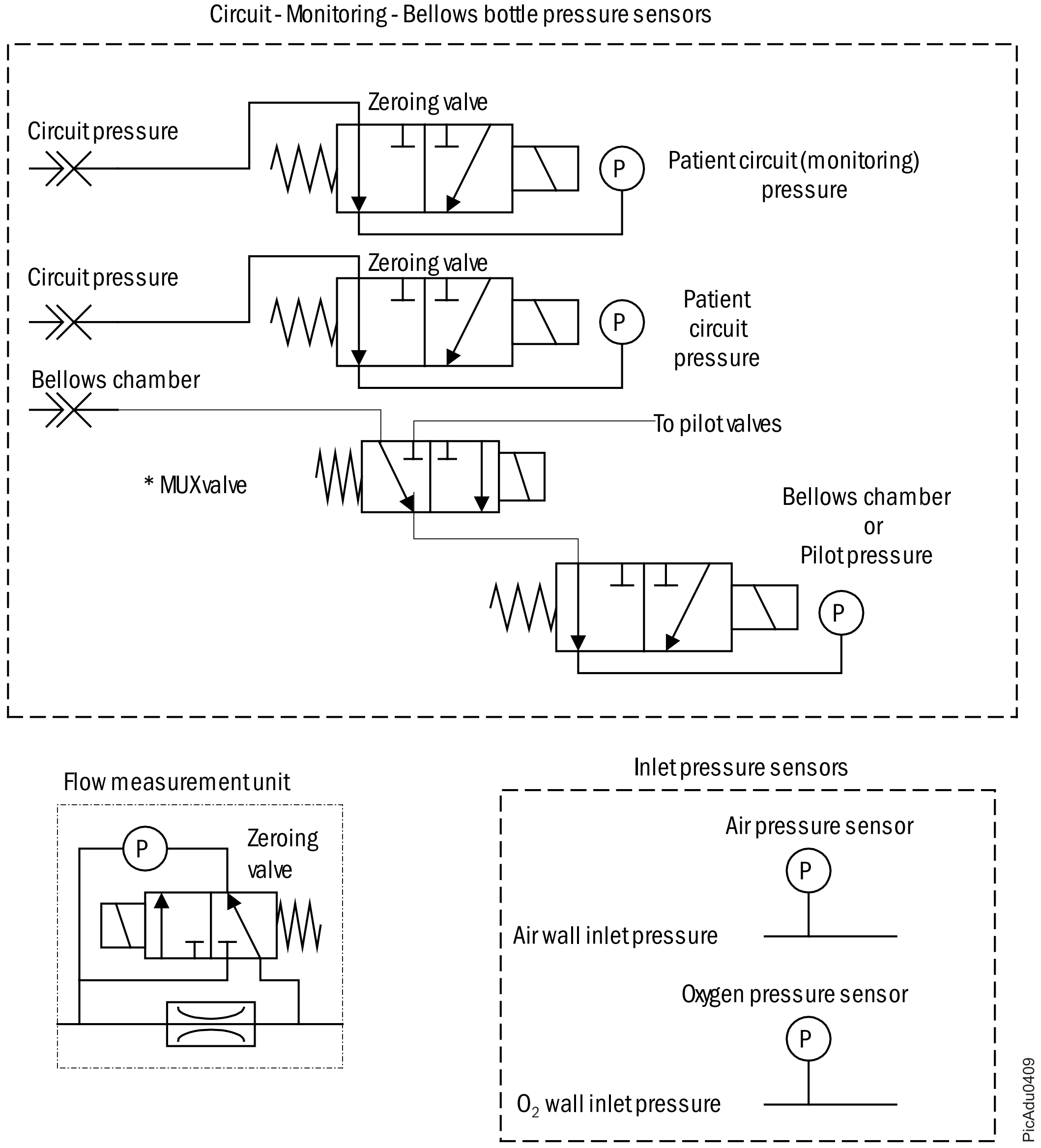

Circuit - Monitoring - Bellows bottle pressure sensors
Circuit pressure
Zeroing valve
P
Patient circuit (monitoring) pressure
Circuit pressure
Zeroing valve
P
Patient circuit pressure
Bellows chamber
To pilot valves
* MUX valve
Bellows chamber or Pilot pressure
P
Flow measurement unit
P
Zeroing valve
Inlet pressure sensors
Air pressure sensor
P
Air wall inlet pressure
Oxygen pressure sensor
P
O2 wall inlet pressure
PicAdu0409

Figure 10 **The pressure sensors and zeroing valves**

Pneumatic chart of the Electronic Ventilator A-EV1

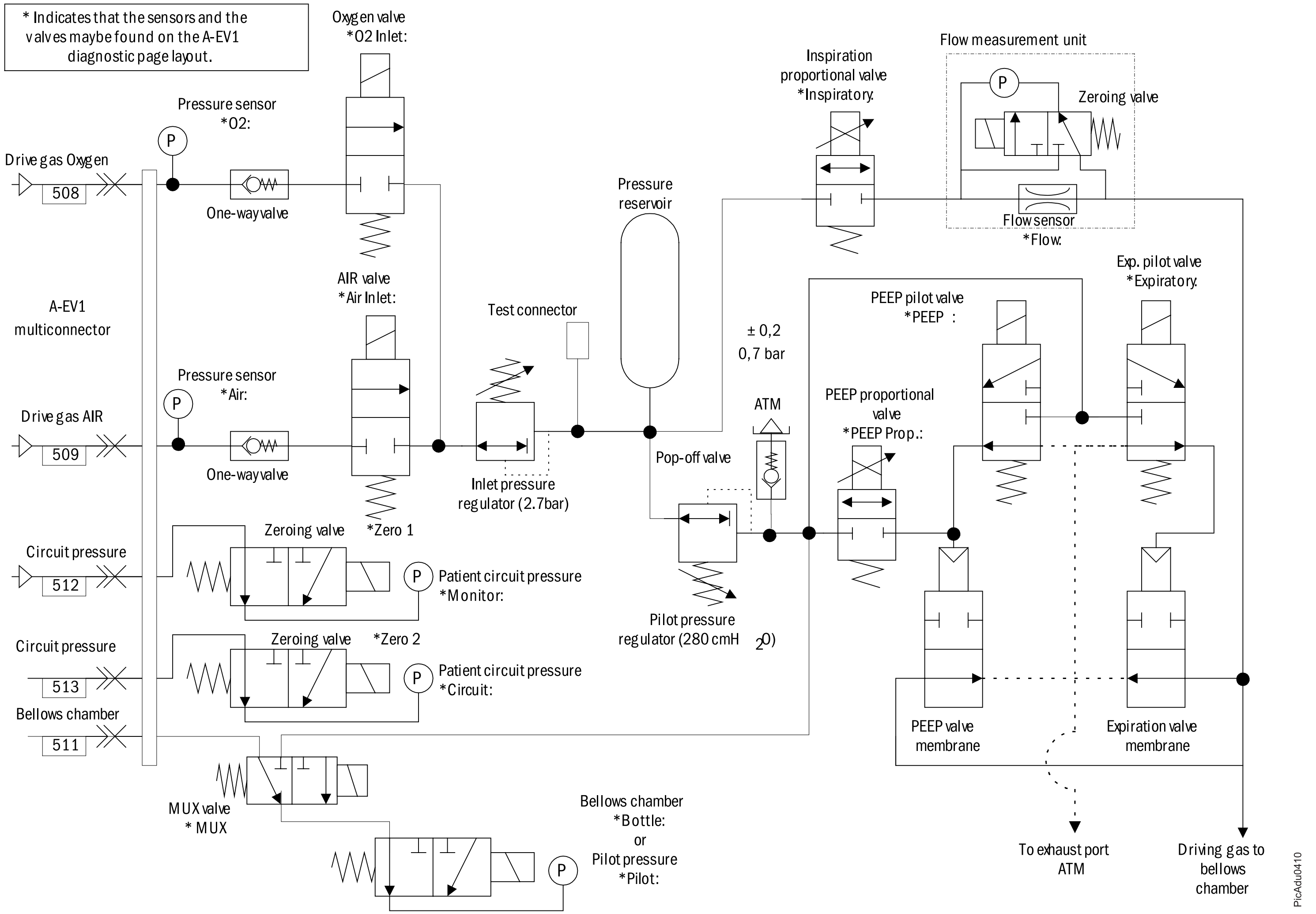
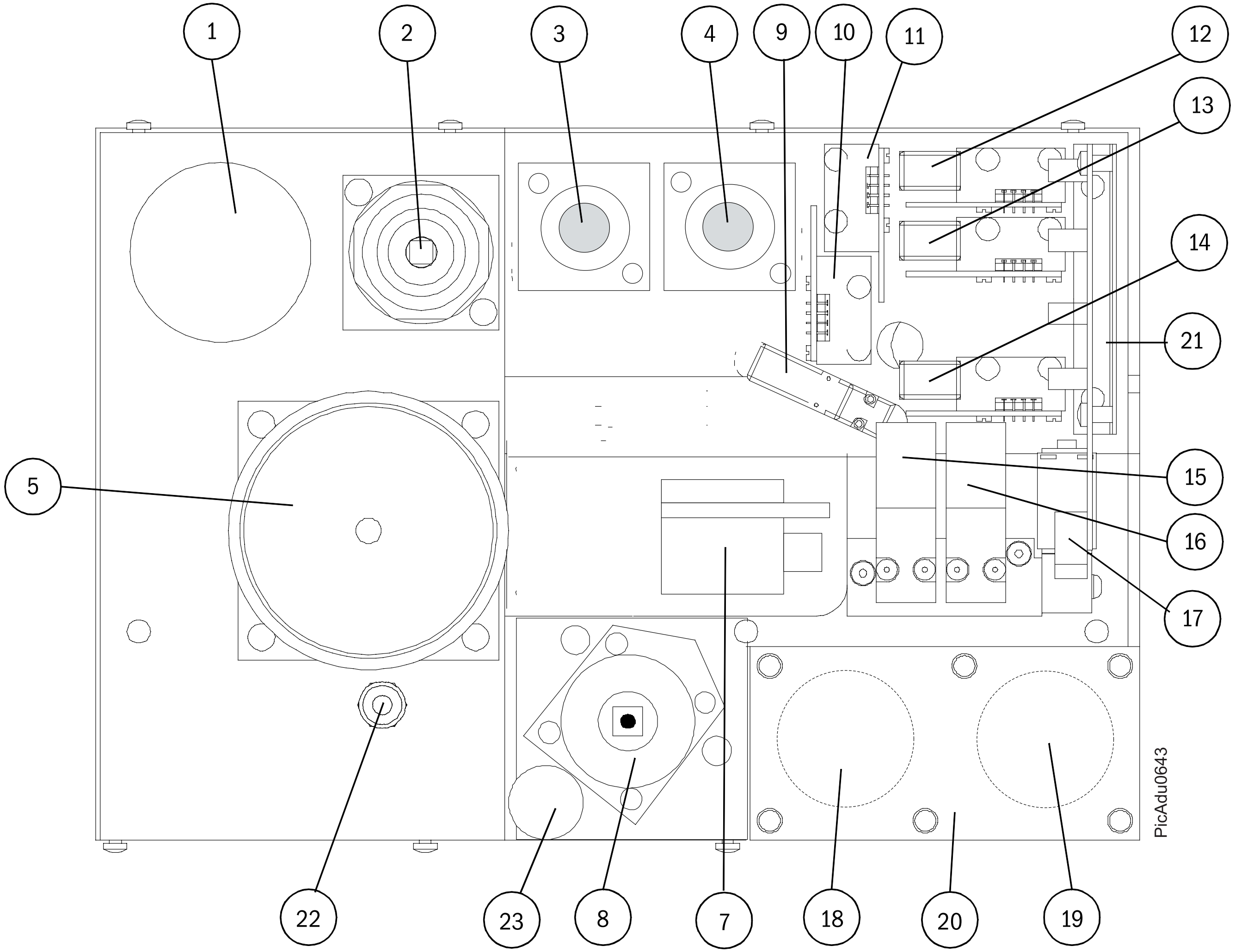

* Indicates that the sensors and the valves maybe found on the A-EV1 diagnostic page layout.
Oxygen valve
*O2 Inlet:
Pressure sensor
*O2:
P
Drive gas Oxygen
508
One-way valve
Inspiration proportional valve
*Inspiratory.
Flow measurement unit
P
Zeroing valve
Flow sensor
*Flow.
Pressure reservoir
AIR valve
*Air Inlet:
Test connector
Exp. pilot valve
*Expiratory.
PEEP pilot valve
*PEEP :
A-EV1
multiconnector
± 0,2
0,7 bar
Pressure sensor
*Air:
P
Drive gas AIR
509
One-way valve
ATM
PEEP proportional valve
*PEEP Prop.:
Pop-off valve
Inlet pressure regulator (2.7bar)
Zeroing valve
*Zero 1
Circuit pressure
512
P
Patient circuit pressure
*Monitor:
Pilot pressure regulator (280 cmH2O)
Circuit pressure
Zeroing valve
*Zero 2
513
P
Patient circuit pressure
*Circuit:
Bellows chamber
511
PEEP valve membrane
Expiration valve membrane
MUX valve
* MUX
Bellows chamber
*Bottle:
or
Pilot pressure
*Pilot:
P
To exhaust port ATM
Driving gas to bellows chamber
PicAdu0410

Figure 11 Pneumatic chart of the A-EV1

Location of ventilator control unit components


1
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21
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15
16
17
PicAdu0643
22
23
8
7
18
20
19

Figure 12 Location of A-EV1 Components

Item	**Item description**
1	Drive gas pressure reservoir
2	Inlet pressure regulator
3	Air valve
4	Oxygen valve
5	Inspiration proportional valve
7	Flow sensor circuit board (newer boards include the Zeroing valve.
8	Pilot pressure regulator
9	MUX valve (pilot pressure test valve)
10	Oxygen sensor pressure board
11	Air pressure sensor board
12	Pressure sensor board with zeroing valve Zero 2 (Circuit)
13	Pressure sensor board with zeroing valve Zero 1 (Monitor)
14	Pressure sensor board with zeroing valve (Bottle pressure)
15	EXP. pilot valve
16	PEEP pilot valve
17	PEEP proportional valve
18	EXP. valve membrane
19	PEEP valve membrane
20	Expiration valve unit
21	Connection board
22	Pneumatic test connector for inlet pressure
23	Pop-off valve

Location of parts in the ventilator control unit

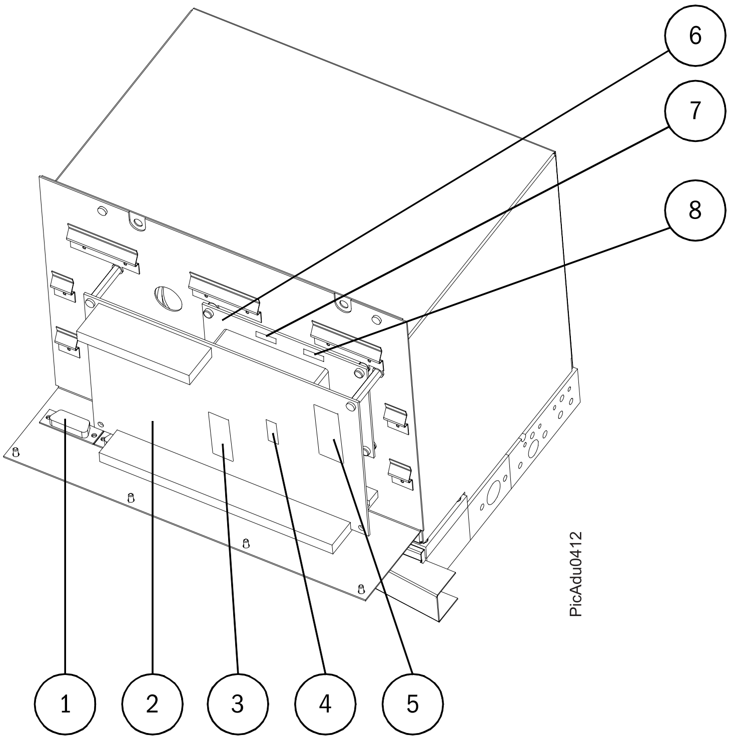


Figure 13 Location of parts in the A-EV1

Item	Item description	Item	Item description
1	VBUS connector	5	A-EV1 software
2	CPU board	6	DC/DC board
3	Back-up processor	7	Fuse F2 630 mA DC/DC board
4	EPROM memory (D7)	8	Fuse F1 2.5A DC/DC board

Electronic Ventilator electronics

Sensors and electromechanical components are located inside the unit. The DC/DC power board, CPU board and back-up processor, are concealed behind the unit.

The components and CPU board are connected to each other via a connection board and a cable. The sensors have their own amplifier boards and the valves are connected directly to the connectors and the board. A single cable connects the units to the CPU board.

All the electronic components are Electromagnetic Interference (EMI) protected inside a shielded frame.

Data on driving parameters, patient circuit pressures, Auto/Man. switch position, delivered tidal volume, used supply of driving gas and some alarms are sent to the ADU central electronics.

The control unit communicates with the ADU central electronics via a serial communication line.

The ventilator CPU board concealed behind the unit, consists of the power/current limiting circuits. Components inside the unit is power limited to below 10 VA because of safety requirements. All power limited driving signals are directed via flat cable from the ventilator CPU board to a ventilator connection board.

DC/DC power board

The DC/DC power board, generates supply voltages for the CPU board and for the pressure sensor boards; +5 V for digital circuits and ±15 V for analogue circuits.

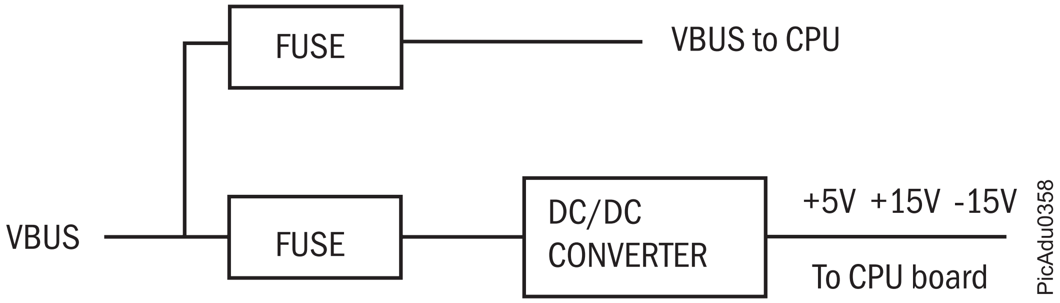


Figure 14 DC/DC power board

CPU board

The CPU controls the functions of the electronically controlled Ventilator. It controls the inspiratory, expiratory and other valves, reads the pressure and flow signals from the transducers, sends the information to the main CPU and receives commands from it through a serial interface.

The processor is a DS80C230, an Intel 51-derivative circuit, accompanied by external RAM for runtime data, external EPROM for software storage and a serial EEPROM for calibration data.

The reset circuit includes power-up reset, supply voltage monitoring and watchdog circuit. The reset signal always causes the outputs to go into off state.

Valve drivers

There are two kind of valve drivers, proportional and on/off -type.

In a proportional valve driver the current setting is analogous, so the current can be set anywhere between zero and max. setting.

The on/off valve drivers are MOS-FET types where the load is connected between the output and the ground.

All valve driver circuits have current limit circuits on the supply side. The product of the short-circuit current and supply voltage is limited below 10 VA, so there is no risk for sparks and therefore fire, in case of an output short to ground.

A reset causes the outputs to go into off state. On proportional valve drivers this is performed by disabling the positive supply side on the current limit circuit. This means that the inspiratory valve will be closed while the expiratory and peep valves are open. The pressure from the patient circuit is thus released.

Auto/Man. switch input

The input for the Auto/Man. switch has two digital lines with pull-up resistors. External switches connect the lines to ground.

Analogue input

For analogue inputs there is a 16-bit A/D-converter on the board. Two eight channel analogue multiplexers are required to select and measure all input voltage channels. In addition to the pressure and flow signals, the supply voltages are also measured for self diagnostics.
The input voltage of the analogue channels of the board, range from 0 to 10V. It is divided by two in a resistor network to convert it into the input voltage range of the A/D-converter. The A/D-converter uses +5V reference voltage which also is employed in generating the +10V supply for the pressure sensors.

Back-up processor

The back-up processor ensures patient safety by releasing high patient circuit pressures in the Auto mode. The back-up processor opens the expiration and PEEP valves and closes the inspiration valve if the pressure in the patient circuit rises above the limit set by the User, +20% or 5 cmH$_2$O approximately.

The back-up processor is located in the serial data line between the central electronics CPU and the ventilator CPU. The back-up processor picks out the information from the messages that the central electronics CPU sends to the ventilator CPU. The needed information is the state of the ventilator CPU and the pressure release limit value. The back-up processor receives the pressure information from the two pressure sensors in the patient circuit.

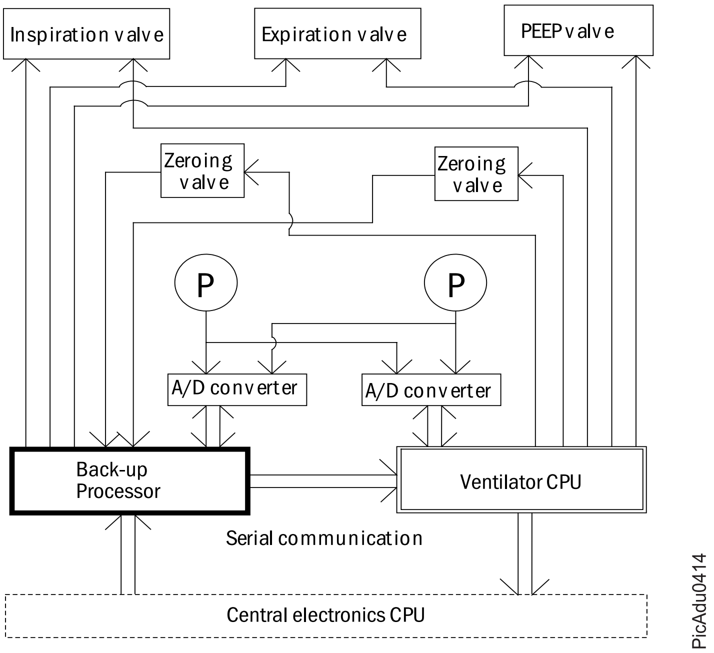


Figure 15 The back-up processor

NOTE: The Backup processor is unaffected by the pressure calibration if the sensors are calibrated for too low pressures. The pressure release in that case works through a back-up processor action.

Voltage supply

The CPU board requires several supply voltages:

- +5V for the digital electronics
- +15V and -15V for the analogue electronics
- VBUS for the valve power supplies

The VBUS voltage is not used directly for driving the valves. There are switching regulators on the board, supplying the power for the valve drivers:

+7V regulator is for the inspiratory valve

+12V regulator is the supply for all the other valve drivers

CPU board block diagram

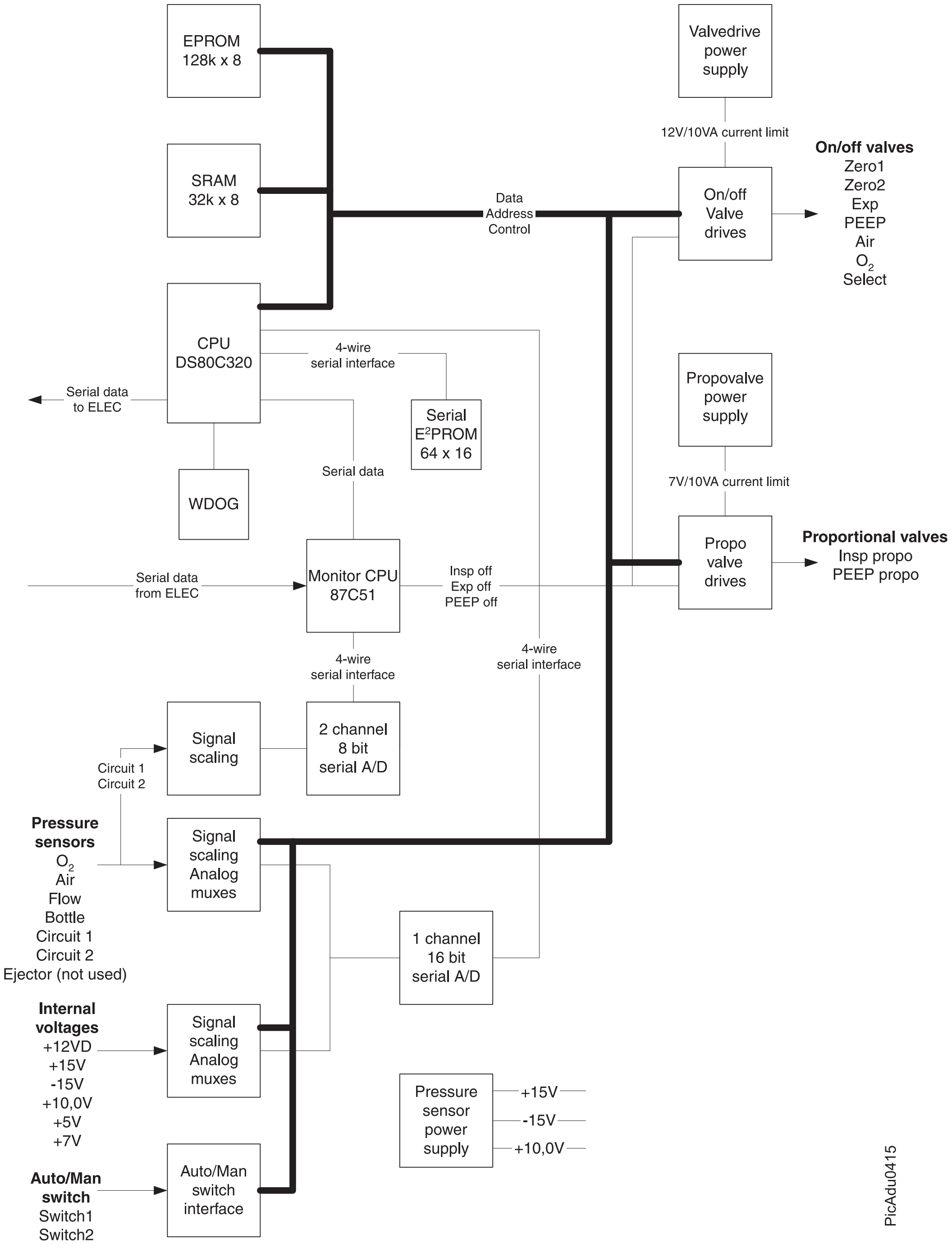

EPROM
128k x 8
SRAM
32k x 8
CPU
DS80C320
WDOG
Data
Address
Control
4-wire
serial interface
Serial
E²PROM
64 x 16
Serial data
Serial data
to ELEC
Serial data
from ELEC
Monitor CPU
87C51
Insp off
Exp off
PEEP off
4-wire
serial interface
4-wire
serial interface
Valvedrive
power
supply
12V/10VA current limit
On/off
Valve
drives
On/off valves
Zero1
Zero2
Exp
PEEP
Air
O2
Select
Propovalve
power
supply
7V/10VA current limit
Propo
valve
drives
Proportional valves
Insp propo
PEEP propo
Signal
scaling
2 channel
8 bit
serial A/D
Circuit 1
Circuit 2
Pressure
sensors
O2
Air
Flow
Bottle
Circuit 1
Circuit 2
Ejector (not used)
Signal
scaling
Analog
muxes
1 channel
16 bit
serial A/D
Internal
voltages
+12VD
+15V
-15V
+10,0V
+5V
+7V
Signal
scaling
Analog
muxes
Pressure
sensor
power
supply
+15V
-15V
+10,0V
Auto/Man
switch
Switch1
Switch2
Auto/Man
switch
interface
PicAdu0415

Figure 16 Block diagram of the CPU board

Ventilator connection board

The ventilator connection board provides signal lines and connectors for the electropneumatic components outside the ventilator box.

The ventilator connection board is connected to the ventilator CPU board by a flat cable.

Electrical flow measurement unit

Driving gas flow to circuit is measured by flow measuring device. This device consists of restrictor and pressure difference sensors. The reading of the sensor corresponds to flow. Flow is calibrated with an external device. There are five calibration points. 2nd order polynomials are fitted to the data. As a result there are four (4) calibration curves for flow sensor. Calibration points are saved into EEPROM and calibration curves are calculated at startup

The flow measurement unit measures the pressure differential in a flow path restrictor.

The flow measurement unit comprises:

- Pressure Sensor

The output voltage of the pressure sensor (tenths of millivolts) is amplified by an amplifier to a level which is suitable for the A/D converter in the ventilator CPU board. The gain of the amplifier is set according to the type of sensor being used and the pressure signal of the measurement unit.

- Flow Restrictor
- Zeroing Valve

The zeroing valve compensates for pressure sensor zero drift.

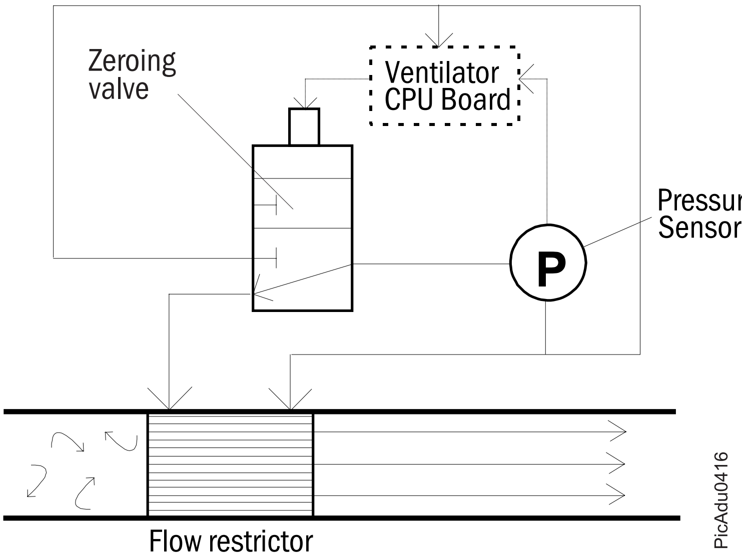


Figure 17 **The electrical flow measurement unit**

Pressure sensor boards

The pressure sensor boards measure the flow and pressure signals. There are six pressure sensor boards in the ventilator control unit:

- The pressure sensor board for driving gas flow during inspiration.
  The measurement is based on the pressure drop in a flow path restrictor. The pressure sensor board consists of a pressure sensor, a flow path restrictor and a zeroing valve to compensate for the pressure sensor zero drift. The pressure sensor board is - pneumatically - positioned downstream the inspiration valve.
- The pressure sensor board for the circuit pressure and the pressure sensor board for monitoring pressures.
  Monitoring and circuit pressure are the same signals. Because the patient circuit pressure has to be checked all the time, this measurement is doubled. When one of them is zeroed the other one is used.

- The pressure sensor board for the bellows chamber pressure/Pilot pressure.
  The chamber pressure is needed for the interruption of the inspiration phase when the bellows reaches its bottom position. The flow and pressure signals are amplified and filtered before being transferred to the A/D converter on the ventilator CPU board. The ventilator CPU board feeds ±15 V to the amplifiers. Each pressure sensor board consists of a pressure sensor amplifier part. There are zeroing valves to compensate for the zero drift of the sensors. Pressure sensors are of differential type. The pressure measurement are done against the ambient pressure. The sensors' supply voltage is +10 V which is created by doubling the +5 V_{ref}.
- The pressure sensor boards for the air and oxygen pressures.
  This information is used for generation of air or oxygen alarms when the inlet pressure is too low (< 2.5 x100 kPa). The inlet gas supply serves the ventilator with its working pressure. The ventilator unit uses either the primary (O_2/Air) or secondary (Air/O_2) gas source. If the pressure of the primary gas drops below 2.5 × 100 kPa, air and oxygen switch positions automatically so that the secondary gas source is used to drive the ventilator unit.

Drive gas selection valves

Usually both air and O_2 are connected to the A-EV1. The User selects which one is the primary gas. Both the primary and secondary driving gas pressures are measured continuously. There is an on /off valve for both pressures. The drive gas supply alarm limit 2.5 bars. Switching limit for the drive gas is also 2.5 bars.

When any one of the supply gases are lost, a O_2 or Air loss alarm message is released. If both gases are lost, the alarm message is ”AIR/O_2 SUPPLY LOST, LOSS of driving pressure”.

A-EV1 may be started with both primary and secondary gas.

Inspiration proportional valve

The inspiration valve is a proportional magnetic valve. Flow through the valve is proportional to the input. The valve is DAC controlled.

The inspiration valve is used in a step-by-step manner in volume and pressure controlled modes. The valve is driven to a predefined current that is unchanged during inspiration.

At the start-up the inspiration valve is calibrated and the calibration is verified.

The closing of the inspiration valve is checked in all mechanical ventilation modes. If it is noticed that the valve is not closed in allocated time, an alarm message is sent.

There is also a way of closing it without checking. It is used for calibration and checks.

PEEP proportional valve

The PEEP control valve is also an analogue valve, opening proportionally to its supplied voltage.

The valve ensures the bleed flow needed to maintain the preset PEEP level during expiration and the pressure level during PCV inspiration.

PEEP and expiration pilot valves

The pilot valves are directly operated 3/2 solenoid valves.

The ventilator CPU and two drivers (power-FET) control the solenoid valves.

The 3/2 solenoid valve lets the driving gas flow from the bellows chamber to an adjusting element during the expiration phase.

Expiration and PEEP membrane

In the beginning of the expiration the PEEP valve membrane opens and relieves the driving gas from the chamber. This decreases the pressure in the patient's airways.

When PEEP is set by the user, the expiration valve membrane is closed by the pilot valve during the expiration phase. The PEEP valve membrane will get the necessary bleed flow from the PEEP proportional valve to maintain the preset PEEP level.

The expiration and PEEP valve membrane is of the 2/2 valve type.

MUX valve

The MUX valve is used for checking the output pressure of the pilot pressure regulator. At every system check, the MUX valve changes position to check the pilot pressure. When the valve is operated into closed position on the diagnostic page, the bottle pressure sensor measures the pilot pressure regulator pressure.

The valve and check may also be operated from the ventilator diagnostic page.

The pilot pressure test valve is a directly operated 3/2 solenoid valve.

Functional description of the Bellows Block

General

The ventilator bellows block unit, A-BB, is located on the left side of the ADU.

The bellows block unit is pneumatically connected to the control unit by a pressure measuring channel and a drive gas channel. Electronically it is connected by micro switches that detect either manual or automatic ventilation mode. The wires for the micro switches are shielded. Voltage is 5 VDC.

In the bellows block, the patient circuit channels and driving gas channels are not directly in contact. The bellows is indirectly connected to the patient circuit through the block. The bellows is only used in automatic ventilation mode. The two main parts of the bellows block are:

- Bottom plate, including
  - Bottom plate with locking mechanism
  - Auto/Man. switch valve with micro switches
  - Connectors for manual bag hose, scavenging and optional ejector
- Bellows Block parts

Description of the Bellows Block Unit A-BB

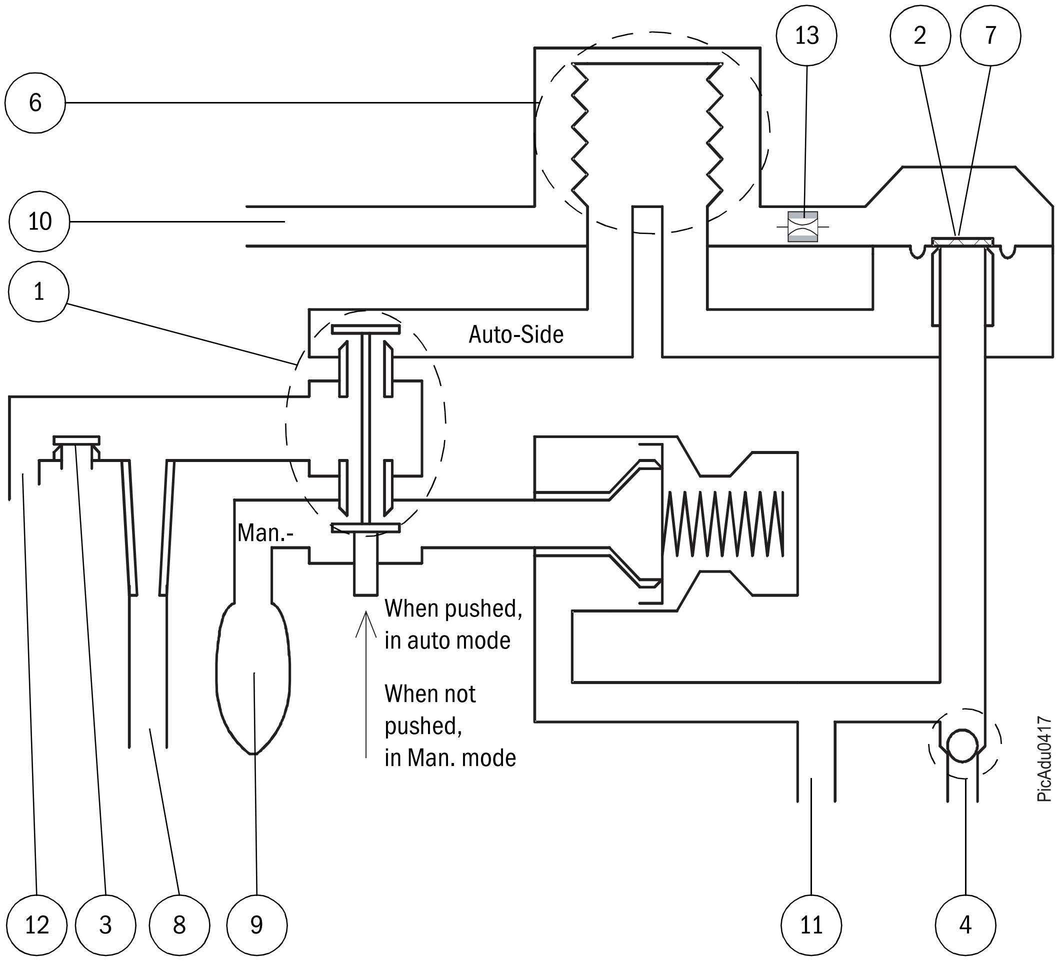

13
2
7
6
10
1
Auto-Side
Man.-
When pushed,
in auto mode
When not
pushed,
in Man. mode
PicAdu0417
12
3
8
9
11
4

Figure 18 The Bellows Block Unit A-BB (Numbers refer to descriptions below)

(1) Auto/Man. switch valve

(2) Overflow valve

(3) Spontaneous breathing valve

(4) Underpressure valve

(5) APL valve

(6) Bellows

(7) Overflow valve

(8) Patient circuit

(9) Manual bag

(10) Driving gas for the bellows

(11) Scavenging reservoir hose ejector

(12) Pressure measuring

(13) Restrictor

Description

The Bellows Block manifold consists of the teflon coated middle and front parts, top and bottom steel plates, top and bottom steel plate rubber sealing and of screws, springs and O-rings. It also includes the bellows plate and the chamber sealing.

1. Auto/Man. switch valve

The Auto/Man. switch valve switches the ventilation modes between Automatic ventilation mode (machine ventilation mode) and Manual ventilation mode. In Auto ventilation mode, the machine ventilates the patient with the bellows. In Manual ventilation mode the anesthetist ventilates the patient with a manual ventilation bag.

2. Overflow valve (also known as Pop-off valve)

The overflow valve does only work in Auto ventilation mode. Its function is to release excess fresh gas from the patient circuit to the gas scavenging system. The overflow valve opens after the bellows has risen to the top of the bellows chamber and the pressure inside the bellows exceeds the pressure between the bellows and the bellows chamber.

3. Spontaneous breathing valve (safety air inlet valve)

The spontaneous breathing valve works both in Auto and Manual ventilation mode. Its function is to prevent under-pressure in the patient circuit if the patient starts to breath spontaneously. The spontaneous breathing valve operates as a simple one-way valve, letting room air flow into but not out of the block.

4. Under-pressure valve

The under-pressure valve, located directly underneath the overflow valve, is used to prevent under-pressure in the scavenging system in both Manual and Auto ventilation modes. Similar to the spontaneous breathing valve, the under-pressure valve operates as a simple one-way valve.

5. APL valve (= Airway Pressure Limiting valve)

The APL valve only works in Manual ventilation mode. Its function is to adjust the max. pressure in the patient circuit. The APL valve is controlled by the anesthetist by turning the APL valve control. The nominal pressure limits of the APL valve are 1.5 cmH_2O and 80 cmH_2O.

6. The bellows and the bellows chamber (also known as the bellows bottle)

The bellows and the bellows chamber works only in the Auto ventilation mode. The bellows in the chamber separates the driving gas of the machine and the patient circuit. The space inside the bellows is connected to the patient circuit, and the space between the bellows and the chamber is connected to the driving gas system of the machine. Its function is to transfer the driving gas pressure to the patient circuit.

7. The overflow valve cap (also known as the Pop-off valve cap)

The overflow valve cap, as the overflow valve itself, only works in the Auto ventilation mode. The overflow valve cap holds the rubber membrane in its place. The overflow valve cap may be removed during washing and sterilization of the Bellows Block.

8. The patient circuit connector

The patient circuit connector is placed next to the manual ventilation bag connector on the underside of the Bellows block. It is used both in Auto and Manual ventilation modes. It is a conical 22 mm male connector, into which the patient circuit hose is connected.

9. The connector for the manual ventilation bag

The connector is placed next to the patient circuit connector on the underside of the Bellows Block. It is a quick coupling into which the manual ventilation bag hose is connected. It is only used in Manual ventilation mode.

10. The driving gas connection at the Bellows Block

The driving gas connection at the Bellows block is in only used in Auto ventilation mode. Trough this connection, the driving gas is pressed into the block and inside the bellows chamber.

11. The scavenging connection at the Bellows Block

The connection is used in both Auto and Manual ventilation modes. Through this connection the used patient gases are routed from the Bellows Block into the scavenging system.

12. The pressure measuring connection at the Bellows Block

The connection is used both in Auto and Manual ventilation modes. The patient circuit pressure is measured in the Bellows Block at this connector.

13. The Restrictor in the overflow valve channel

The restrictor is placed in the gas channel between the chamber to the top of the overflow valve.

The restrictor damps the oscillation effect to the overflow valve during the expiration phase; a too high oscillation in the patient circuit can otherwise affect the spirometry volume measurement.

Bellows Block exterior

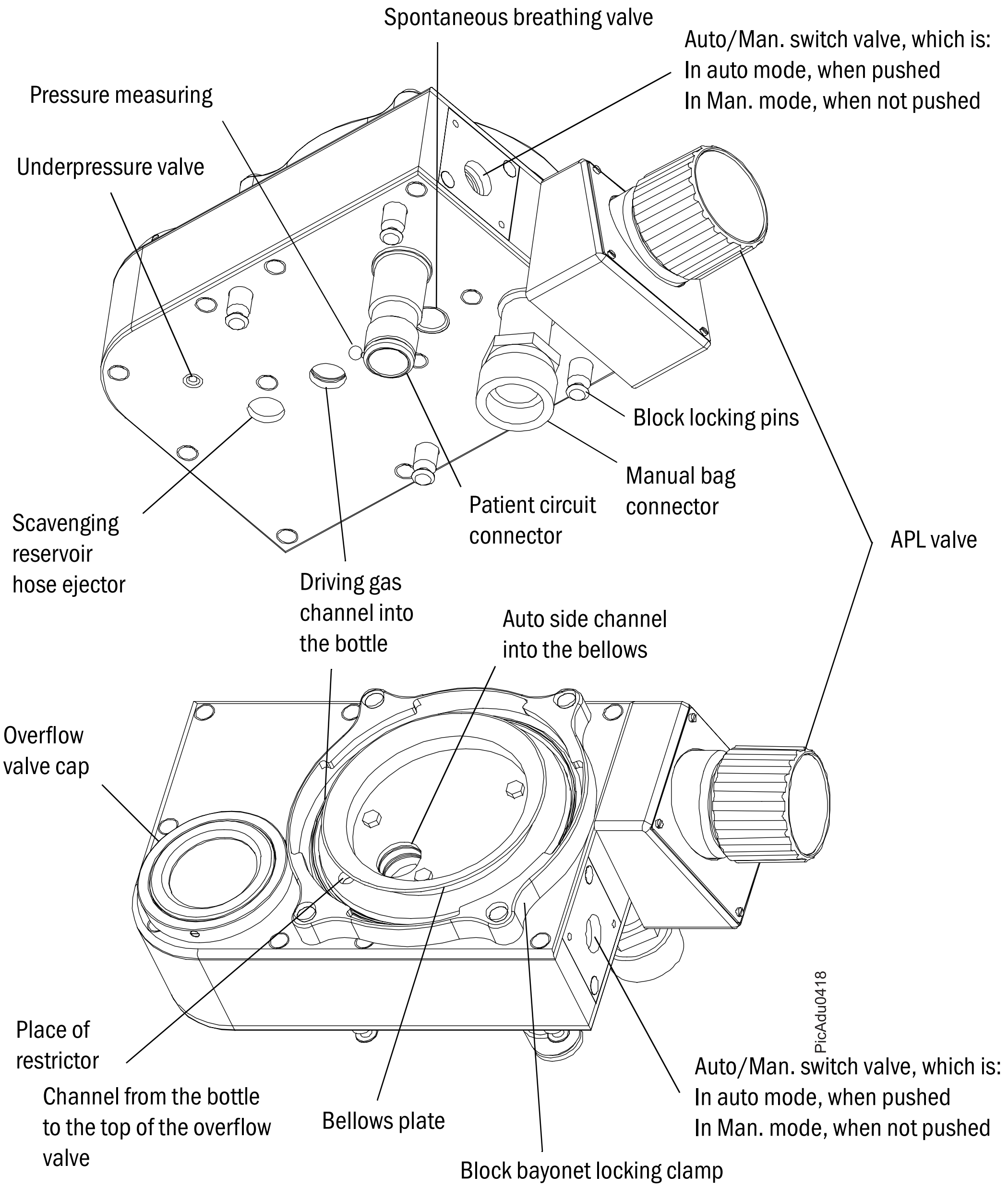

Spontaneous breathing valve
Auto/Man. switch valve, which is:
In auto mode, when pushed
In Man. mode, when not pushed
Pressure measuring
Underpressure valve
Block locking pins
Manual bag connector
Patient circuit connector
Scavenging reservoir hose ejector
APL valve
Driving gas channel into the bottle
Auto side channel into the bellows
Overflow valve cap
PicAdu0418
Place of restrictor
Channel from the bottle to the top of the overflow valve
Bellows plate
Auto/Man. switch valve, which is:
In auto mode, when pushed
In Man. mode, when not pushed
Block bayonet locking clamp

Figure 19 The Bellows Block exterior

Bellows Block interior

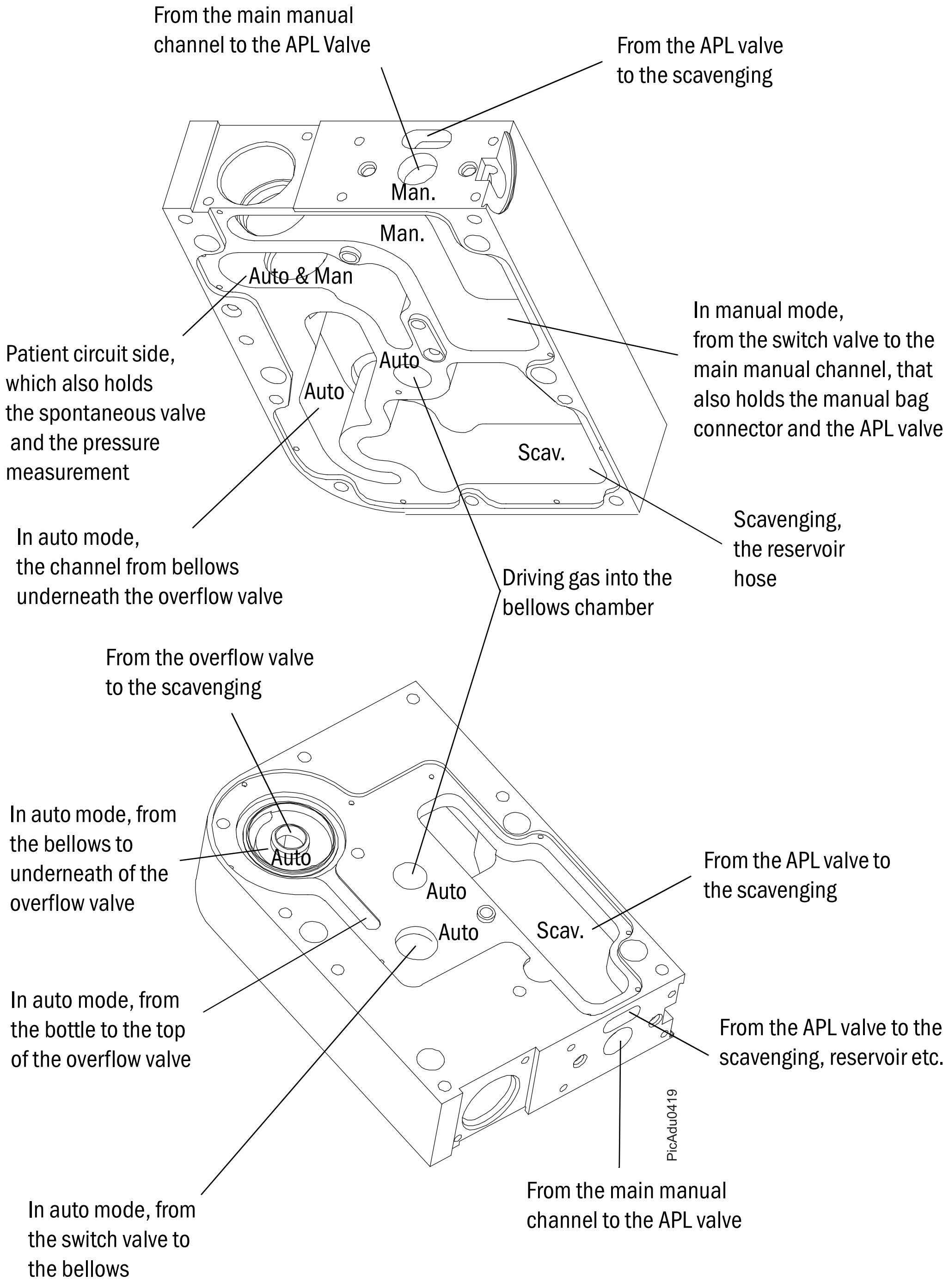

From the main manual channel to the APL Valve
From the APL valve to the scavenging
Man.
Man.
Auto & Man
Patient circuit side, which also holds the spontaneous valve and the pressure measurement
Auto
Auto
In manual mode, from the switch valve to the main manual channel, that also holds the manual bag connector and the APL valve
Scav.
Scavenging, the reservoir hose
In auto mode, the channel from bellows underneath the overflow valve
Driving gas into the bellows chamber
From the overflow valve to the scavenging
In auto mode, from the bellows to underneath of the overflow valve
Auto
Auto
Auto
Scav.
From the APL valve to the scavenging
In auto mode, from the bottle to the top of the overflow valve
From the APL valve to the scavenging, reservoir etc.
PicAdu0419
From the main manual channel to the APL valve
In auto mode, from the switch valve to the bellows

Figure 20 The Bellows Block interior

REPAIR INSTRUCTIONS A-EV1

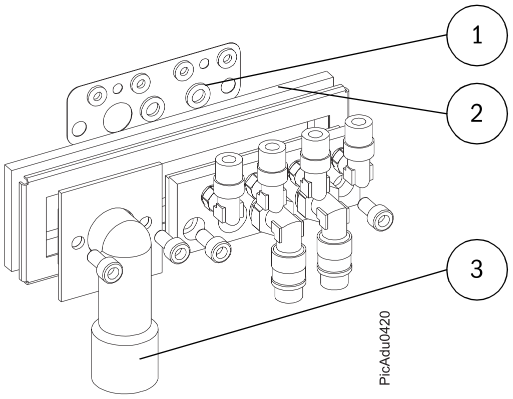
General

Repairs not only means replacement of parts/unit but also some service and miscellaneous information.

Dismounting the Electronic Ventilator unit from the ADU

Tools: *Flat-blade screwdrivers*
Cross-head screwdriver
Allen wrench 2.5 and 4 mm
Spare parts: Electronic ventilator (A-EV1)

1. Disconnect the pipeline supply gases and close cylinder valves.
2. Turn the N_2O/Air switch into N_2O position. Release the N_2O and air pressures by first fully opening the N_2O flow and then opening the O_2 flow to 1 l/min.
3. Turn the N_2O/Air switch to Air position. Release the air pressure by opening the Air flow control.
4. Turn off the ADU and disconnect the power plug from the wall socket.
5. Remove the rear plastic cover (8 Allen screws including toothed washers.)
6. Check that the Auto/Man. switch is in Man. position.
7. Remove the ventilator hoses from the bellows block. Lift the bellows block from the bottom plate.
8. Remove the upper left side cover close to the bellows block. (Allen screws)
9. Disconnect multi-connector A-EV1, (Two Allen screws) drive gas tube and seals behind it (see Figure 21 on page C-27).



1. Seal EV1 connector
2. Seal
3. Drive gas tube

Figure 21 **The A-EV1 multi-connector**

10. Remove the four Allen screws holding the ventilator to the frame.
11. Pull out the ventilator far enough to allow the VBUS and micro switch connectors to be detached with a flat blade screwdriver from the ventilator unit.
12. Take out the ventilator unit.

Remounting the Electronic Ventilator to the ADU

Remounting is essentially reversing what was described in *"Dismounting the Electronic Ventilator unit from the ADU" on page C-27*.

CAUTION Make sure that the seals for the A-EV1 multi-connector and drive gas tube are correctly seated before they are fastened.

After remounting, check that the primary driving gas setting is correct in the ventilator control unit software. The setting can be checked on the ***Setup - Service*** menu.

If the setting is not correct, select ***Setup - Install*** menu using the distributor password. Switch the primary gas to the correct one and check the setting on the service menu page.

Carry out the Functional Check to assure the functioning of the ventilator.

Replacing the EEPROM memory and A-EV1 software

In case of a CPU board (1) failure, move the EEPROM memory (2) or software (3) from the old CPU board to a new CPU board, see Figure 22 on page C-28 and Figure 23 on page C-29. In this way there is no need for a recalibration. If a new EEPROM is installed, a complete recalibration is necessary.

The EEPROM memory contains the module serial numbers and calibration data.

When ordering an EEPROM circuit as spare part, the serial number of the unit where it shall be installed should be stated.

If the software or the EEPROM is replaced, carry out a Functional check.

To replace the EEPROM or software proceed as follows:

1. Mains or gas supplies must not be connected to the unit.
2. Remove the rear plastic cover of the ADU and the metal cover over the A-EV1.
3. Replace the EEPROM (Chip socket D7 on circuit board) or the A-EV1 Software and refit the covers. Make sure the software and EEprom will be installed correctly. Indication shall be orientated as shown in Figure 23 on page C-29.
4. Reconnect the pipeline gases and the mains supplies.

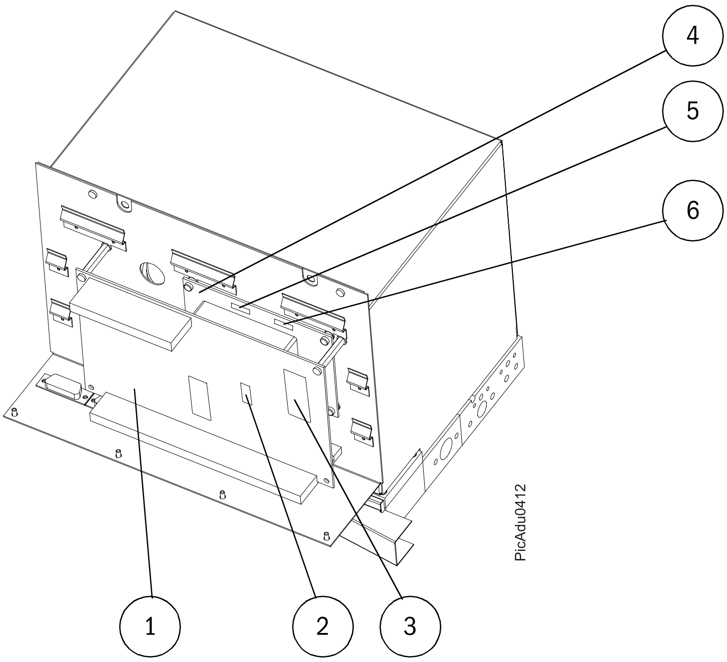


Figure 22 The A-EV1

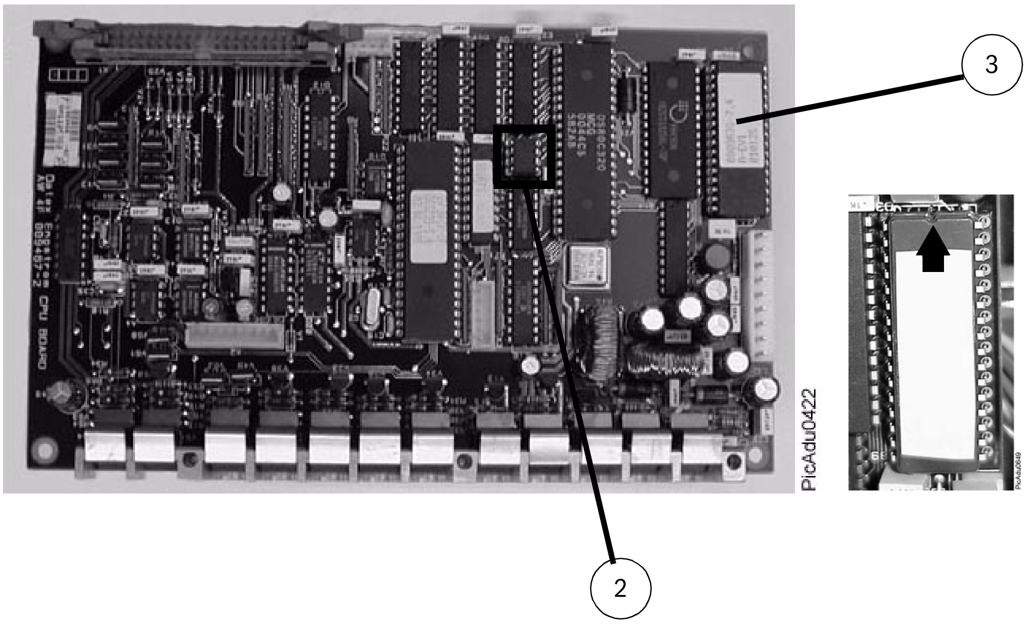

3
2
PicAdu0422
PicAdu0649

Figure 23 **The CPU board**

Replacing the DC/DC power board fuses

To replace the fuses on the DC/DC power board ((4) in figure Figure 22 on page C-28) proceed as follows:

1. Ensure that mains and pipeline gases are disconnected.
2. Remove the rear plastic cover of the ADU and the metal cover of the A-FGC1.
3. Replace fuse F1 (5) or F2 (6) located on the DC/DC board (4), see Figure 22 on page C-28. F2 = 630 mA, F1 = 2.5A
4. Refit covers.
5. Reconnect pipeline gases and mains.

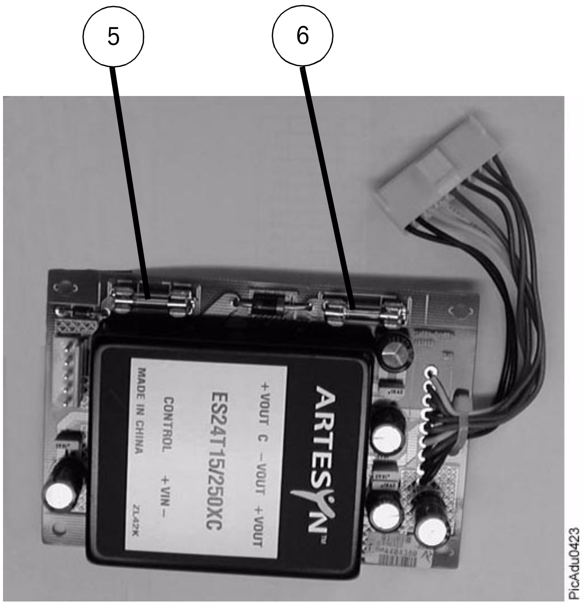

5
6
ARTESYN
ES24T15/250XC
PicAdu0423

Figure 24 **The DC/DC board**

Servicing the Bellows Block with bottom plate

Removing and reinstalling the APL valve on the Bellows Block

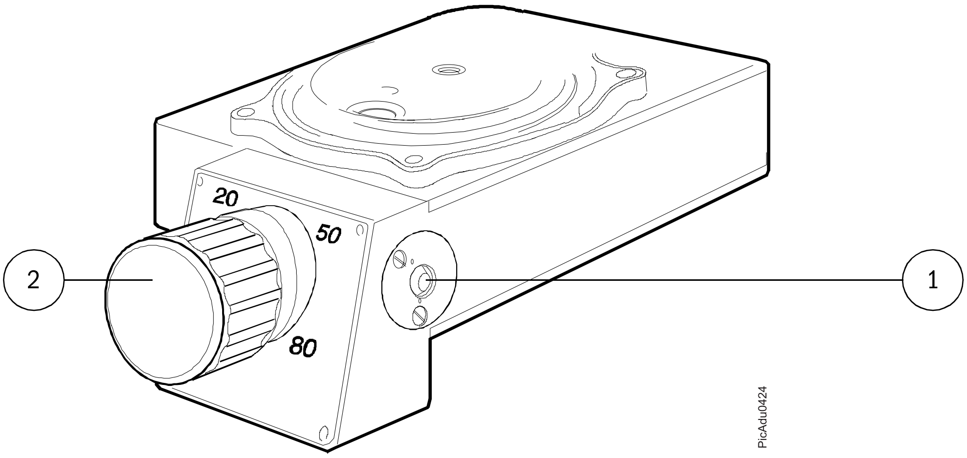


Figure 25 The APL valve on the Bellows Block

1. Disconnect the Bellows Block.
2. Push the bayonet release button (1) and keep it down.
3. The APL valve is supplied with a bayonet locking mechanism. Turn the whole APL valve (2) 90° counter-clockwise and then pull it straight out. Remember the position of the APL valve to make reinstallation easier.

Installing the APL valve to the Bellows Block:

1. Push the bayonet release button (1) and keep it down.
2. Carefully push the APL valve into the Bellows Block and turn it clockwise until the release button pops up.

Removing and changing O-rings of the Auto/Man. switch valve

Tools: Allen wrench 2.5 mm

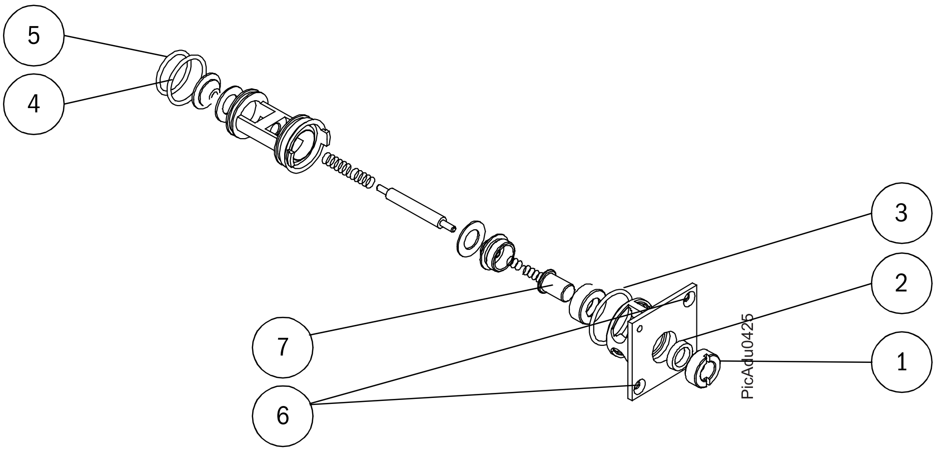


Figure 26 The Auto/Manual mode switch valve

1. Disconnect the Bellows Block.
2. Unfasten the two Allen screws (6).
3. Remove both screws (6).
4. Reinstall the screws into the opposite corners, alternate tightening the screws until the valve assemble becomes free. By carefully turning the screws clockwise, the plate will leave its original position enough to let it be removed completely.
5. Replace the O-rings (3,4,5)

To exchange the lip seal (item 2):

6. Unfasten short screw (1) by applying a screwdriver in the slots.
7. Press down shaft (7) and at the same time release lip seal (2).
8. Reassemble the Auto/Man. switch valve in reversed order.

Cleaning the Auto/Man. switch

First remove the O-Rings from the Auto/Man. switch as described in “Removing and changing O-rings of the Auto/Man. switch valve” on page C-31:

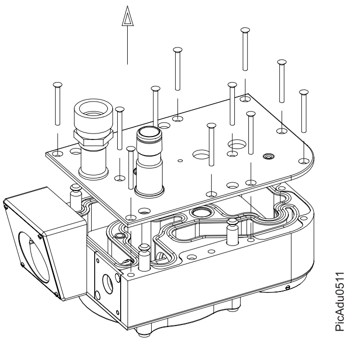
1. The valve can either be immersed in isopropyl alcohol or similar cleaning agent or the agent can be sprayed on. The valve mechanism (7) should be partially pushed down to allow the cleaning agent can reach all areas of the valve.
2. Dry all parts thoroughly after cleaning. Inspect all parts for damage and replace the valve if necessary
3. Refit the O-rings or replace them with new ones.

Replacing the spontaneous valve 894613

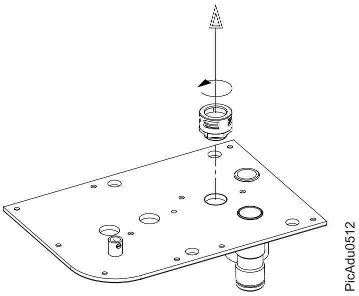
Special Tools needed: Loctite 243

Wrench 23 mm (maximum 3.5 mm thick).

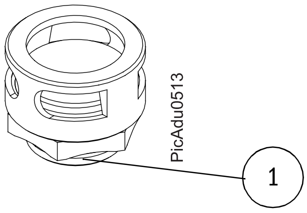
1. Remove the bellows chamber, bellows, overflow valve cap and overflow valve membrane from the bellows block.
2. Turn the bellows block upside-down
3. Remove the plate screws.



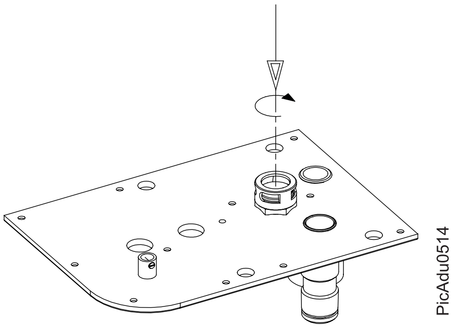
4. Remove spontaneous valve and clean the plate threads from dirt.



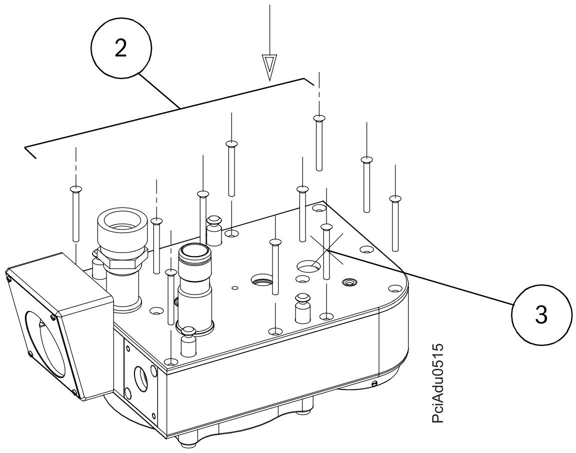
5. Apply Loctite 243 to the threads of the new spontaneous valve (1).



6. Fit the new valve (including O-ring) to the plate. Do not tighten too hard as it may cause leakage.



7. Apply Loctite 243 to all the plate screws (2) with the exception of screw (3) as it is not should be used after installing the valve 894613 used.



8. Check that the seal (P/No: 886418) between the plate and the bellows is in good condition before reassembly.
9. Refit the plate and tighten the screws.
10. Carry out a System Check after installation of the Bellows Block.

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CALIBRATION A-EV1

General requirements

- The measuring equipment shall be accurate and calibrated
- There are many types of flow and pressure test devices available that can be used to complete this procedure. Datex-Ohmeda recommends no specific device. Specifications are provided with this chapter. The flow and pressure test devices should have an accuracy of +/-2,5% or better.
- Datex-Ohmeda assumes that technical and biomedical professionals know how to use the device available at his/her institution. Therefore, test device instructions are not included here.
- If a check do not pass a test, verify and make sure that your test devices and its setup to the measuring point are correctly done before starting to calibrate or changing parts.
- Before flow calibration, ambient pressure on ADU shall be set on the average level of the region. Also Manual and Auto leak check should be done.
- The ADU is calibrated in ATP (ambient temperature and pressure).
- Always makes sure to understand the function of the test devices before calibration.
- Always remembers to not have any measuring tubes connected to the test device when you Zeroing it.
- The calibration procedure must follow the order as specified in the calibration tree below.

Entering calibration mode

Before performing any Ventilator calibration, make sure that the ventilator is in calibration mode:

1. Enter the Service menu and ***Calibration - Ventilator***.
2. Check that the text ***AUTO*** or ***MAN*** has changed to ***Calibrating*** in the mode selection field of the display.
3. If not return to previous menu and select ***Ventilator Diagnostic*** menu.
4. Enter pneumatic controls

CAUTION Do not make any changes on valves

5. Return to ***Ventilator Calibrating*** menu and check that the text in the mode selection field has changed to ***Calibrating***.
6. Perform calibration.

The ventilator calibrating tree

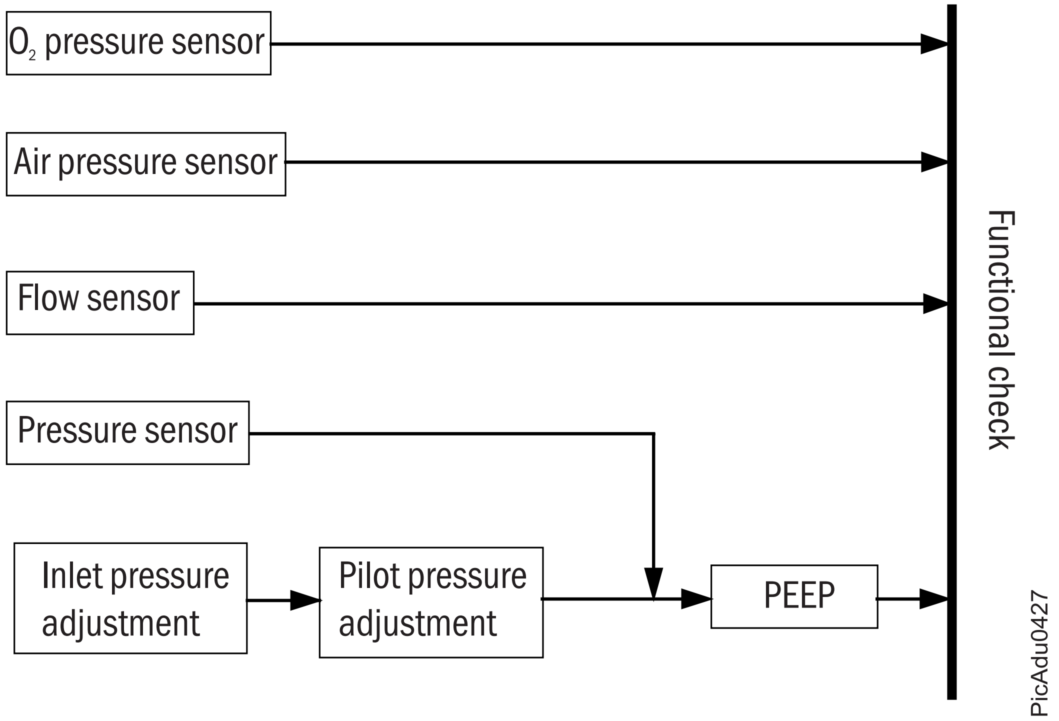

O_2 pressure sensor
Air pressure sensor
Flow sensor
Pressure sensor
Inlet pressure adjustment
Pilot pressure adjustment
PEEP
Functional check
PicAdu0427

Figure 27 **The ventilator calibrating tree**

O_2 and air pressure sensor calibration

This procedure calibrates the wall pressure sensors. These sensors are used to detect if wall pressures are lost and to switch driving gas if driving gas selected by the user, is lost. The calibration factors are saved in EEPROM 41 and 42 for air and EEPROM 43 and 44 for O_2.

Equipment needed: *Pressure test device*
High pressure Test adapter

Settings: *Reserve gas cylinders closed*
ADU On
Manual mode
Flows closed
Air/N_2O selector switch in Air position

1. Disconnect the gas inlet hoses O_2, N_2O and air from the A-WGU (gently because of the high pressure).
2. Enter relevant range on the test device.
3. Zero the test device. The reading on the test device screen should be 0.0.
4. Connect the high pressure test adapter and test device as figures show below.

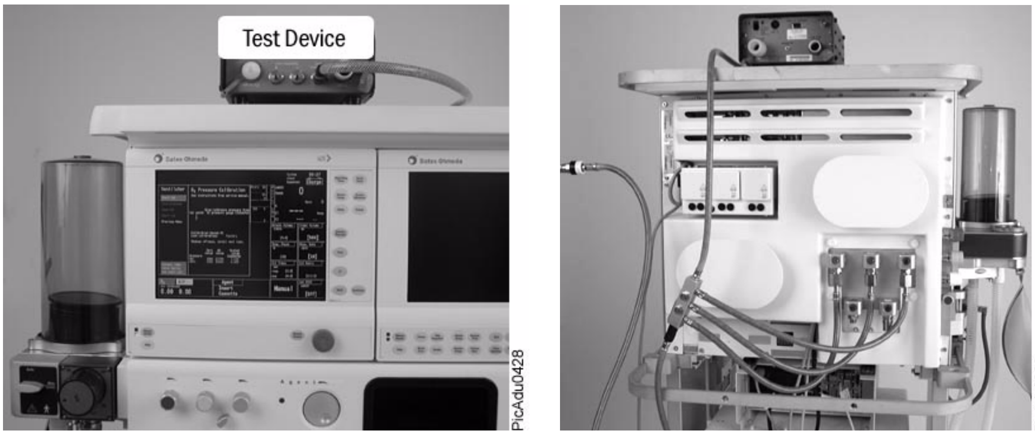
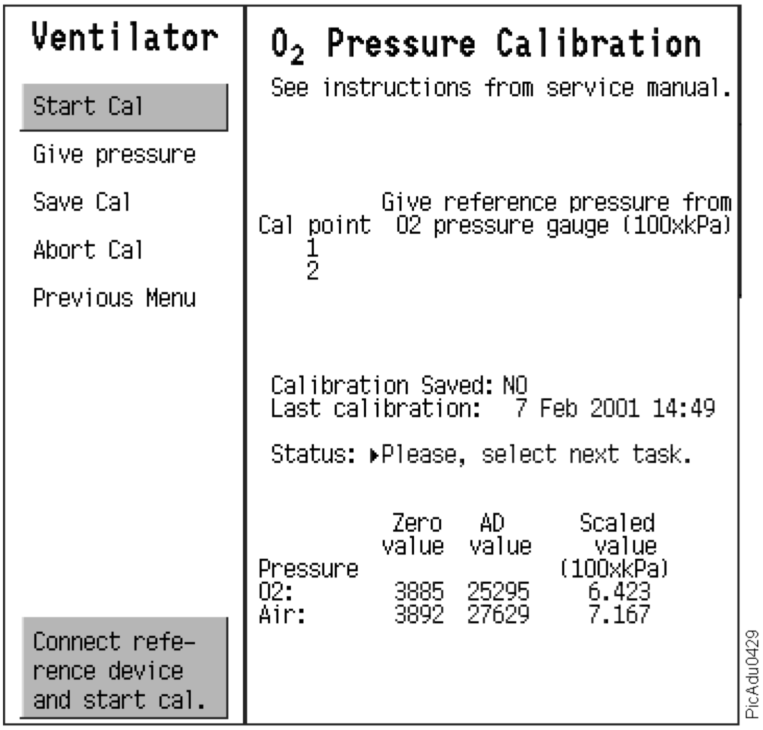


Figure 28 O_2 and air pressure sensor calibration test setup

5. Push the **Setup** key. Select ***Service*** and enter the calibration password. Select ***Calibrations - Ventilator - O_2 pressure or Air pressure*** page depending on which sensor to be calibrated.


Ventilator
Start Cal
Give pressure
Save Cal
Abort Cal
Previous Menu
Connect refe-rence device and start cal.
PicAdu0429

```
O2 Pressure Calibration
 See instructions from service manual.

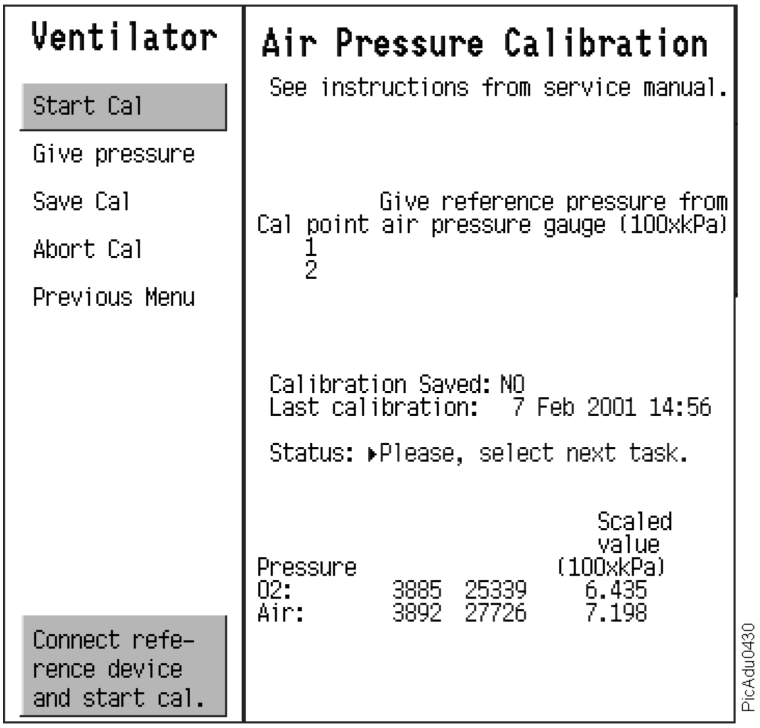
         Give reference pressure from
Cal point  O2 pressure gauge (100xkPa)
    1
    2

 Calibration Saved: NO
 Last calibration:   7 Feb 2001 14:49

 Status: ▸Please, select next task.

           Zero   AD      Scaled
          value  value     value
Pressure                 (100xkPa)
O2:        3885  25295     6.423
Air:       3892  27629     7.167
```

Figure 29 Calibration - Ventilator - O_2 pressure page


Ventilator
Start Cal
Give pressure
Save Cal
Abort Cal
Previous Menu
Connect refe-rence device and start cal.
PicAdu0430

```
Air Pressure Calibration
 See instructions from service manual.

         Give reference pressure from
Cal point air pressure gauge (100xkPa)
    1
    2

 Calibration Saved: NO
 Last calibration:   7 Feb 2001 14:56

 Status: ▸Please, select next task.

                           Scaled
                            value
Pressure                 (100xkPa)
O2:        3885  25339     6.435
Air:       3892  27726     7.198
```

Figure 30 Calibration - Ventilator - Air pressure page

6. Start calibration by selecting ***Start Cal***.
7. Read pressure from the test device and give correct reference pressure to calibration point 1 (100×kPa).
8. Disconnect the test adapter gas inlet from central outlet.
9. Open O_2 (or Air depending of what flow that is calibrated) needle valve.
10. Read pressure from the test device and give correct reference pressure to calibration point 2 (100×kPa) which normally is 0.
11. Wait until ‘Calibration OK’ or ‘Calibration failed’ is displayed.
12. Save the calibration by selection ***Save Cal***. To abort calibration, select ***Abort Cal***.
13. Close flow and repeat above procedure for the other pressure sensor.
14. Disconnect test equipment and reconnect the gas inlet hoses O_2, N_2O and air to the A-WGU.
15. Select ***Previous menu***. Perform the needed calibrations according to the calibration tree.

Flow sensor calibration

This procedure calibrates the flow sensor of the ventilator but also creates a reference table for the inspiration valve. The calibration is divided into two parts: User controlled flow sensor calibration and internally controlled inspiration valve calibration. The inspiration valve calibration is used later as a reference to find out if the inspiration valve or flow sensor is faulty. The calibration factors for the flow sensor are stored in EEPROM 20-29. The reference table for inspiration valve is stored in EEPROM 30-39. The number of flow calibration points are store in EEPROM 40. The zero point of the flow sensor is calibrated every minute during normal operation.

Equipment needed: *Flow/pressure test device*

Settings: *ADU On*
Pipeline gases connected
Ventilator in calibration mode

CAUTION Make sure the ventilator is in calibration mode

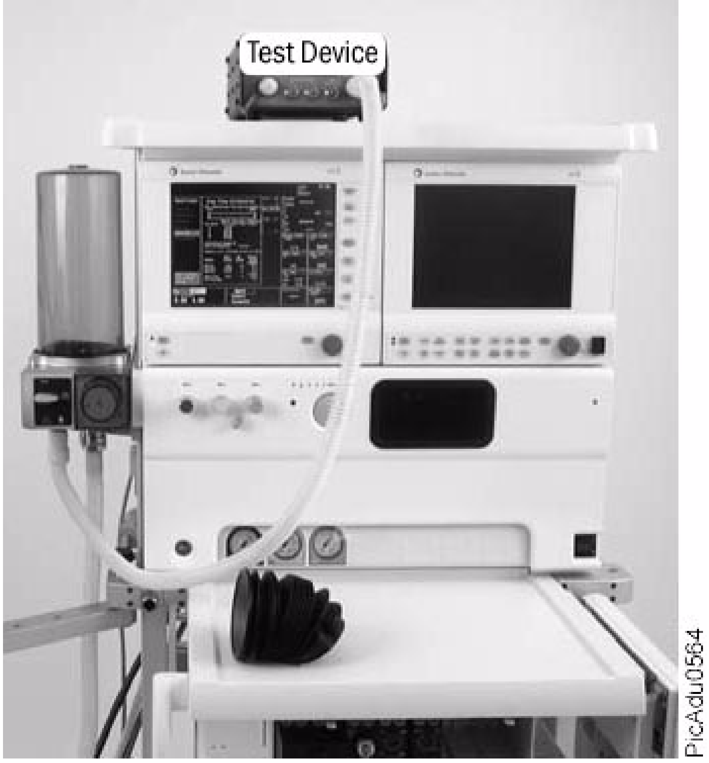
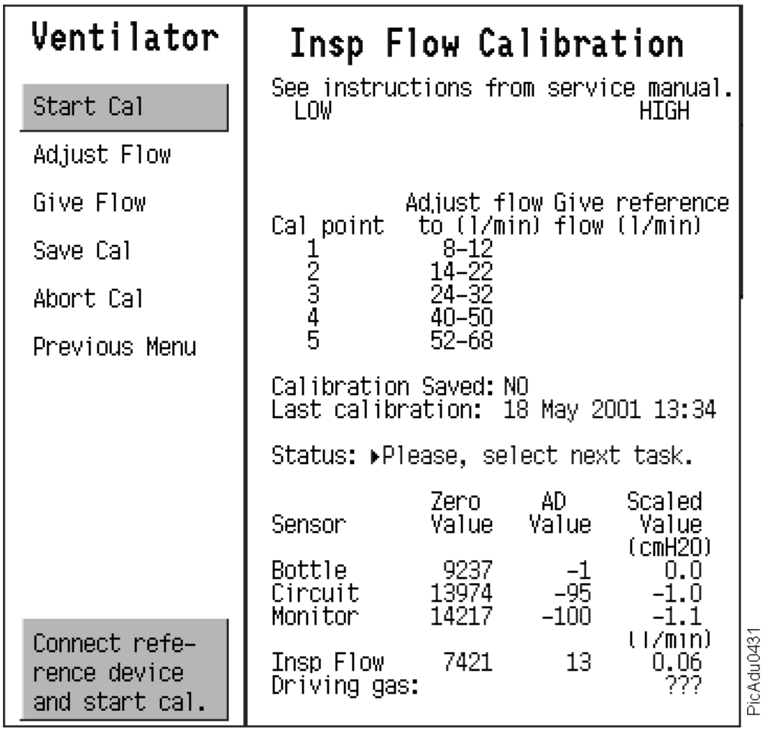


Figure 31 Flow sensor calibration

1. Check if the ventilator is driven on O_2 or Air, then select the flow measurement range for that kind of gas on the test device (0-180 l/min). Push the zero key on the test device. The reading on the test device should be 0.0.
2. Turn the Auto/Man. switch to Man. position. Remove the bellows and refit the bellows chamber.
3. Detach the ventilator hose from the patient circuit and connect it to the test device high flow range inlet.
4. Push the **Setup** key. Select ***Service*** and enter the calibration password. Select ***Calibration - Ventilator - Flow.***



```
Insp Flow Calibration
See instructions from service manual.
  LOW                           HIGH


              Adjust flow Give reference
Cal point      to (l/min) flow (l/min)
   1             8-12
   2            14-22
   3            24-32
   4            40-50
   5            52-68

Calibration Saved: NO
Last calibration:  18 May 2001 13:34

Status: ▸Please, select next task.

               Zero      AD     Scaled
Sensor        Value    Value     Value
                                (cmH2O)
Bottle         9237       -1       0.0
Circuit       13974      -95      -1.0
Monitor       14217     -100      -1.1
                                 (l/min)
Insp Flow      7421       13      0.06
Driving gas:                       ???
```

Figure 32 **Calibration - Ventilator - Flow page**

5. Start the calibration by selecting ***Start Cal***.

Status:

- Closing expiration 2 valve.
- Closing support valve.

6. Turn the Auto/Man. switch to Auto position.
7. Select ***Adjust flow***. Adjust flow to the first calibration point (8-12 l/min.) by turning the ComWheel. Let stabilize for one minute. Push the ComWheel after the adjustment.
8. Enter the reference flow by selecting ***Give flow*** and turning ComWheel (a lot) to match the test device's reading. Push the ComWheel. Repeat steps (8) and (9) for the next four calibration points (14-22, 24-32, 40-50 and 52-68 l/min.).
9. Wait until the ventilator stops working with the inspiration valve reference table (this can take several minutes) before saving the calibration by selecting ***Save Cal***. A indication when the calibration can be saved is also when your test device stopped indicating any flow (0.0).

NOTE: If the calibration is saved before the inspiration valve reference table is done will the old calibration values remaining if calibration is saved.

NOTE: If a completely wrong calibration have been saved may the Ventilator stay in the Ventilator self-check. And then might it be necessary to make the calibration several times to be able to attain correct reference flow.

To abort calibration, select ***Abort Cal***.

10. Refit the bellows.
11. Select ***Previous menu***.
12. Perform calibration according to the calibration tree.

Pressure sensors calibration

This procedure calibrates the gain of the pressure sensors in the ventilator. The gains are stored in EEPROM 2 (monitor), EEPROM 3 (circuit) and EEPROM 4 (bottle). The zero points for these sensors are calibrated every minute during normal operation.

Equipment needed: *Flow/pressure test device*

Settings: *ADU On*
Pipeline gases connected
Flows closed
Manual Mode

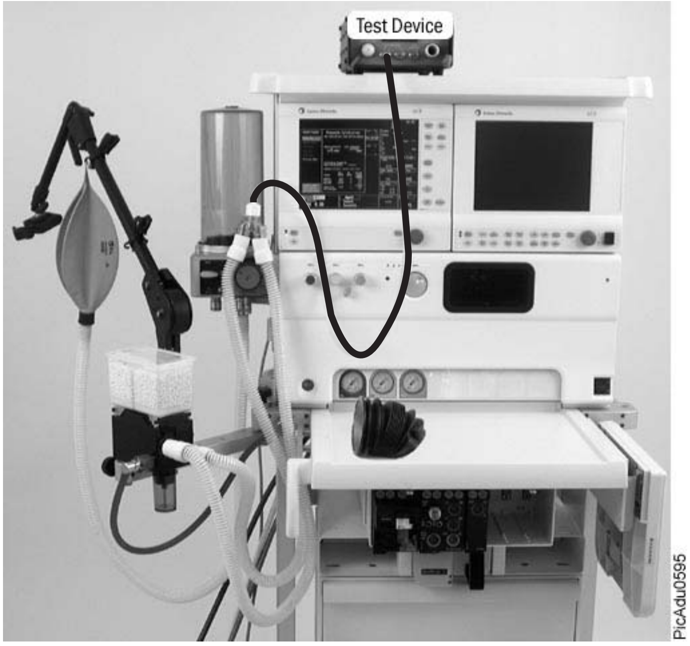
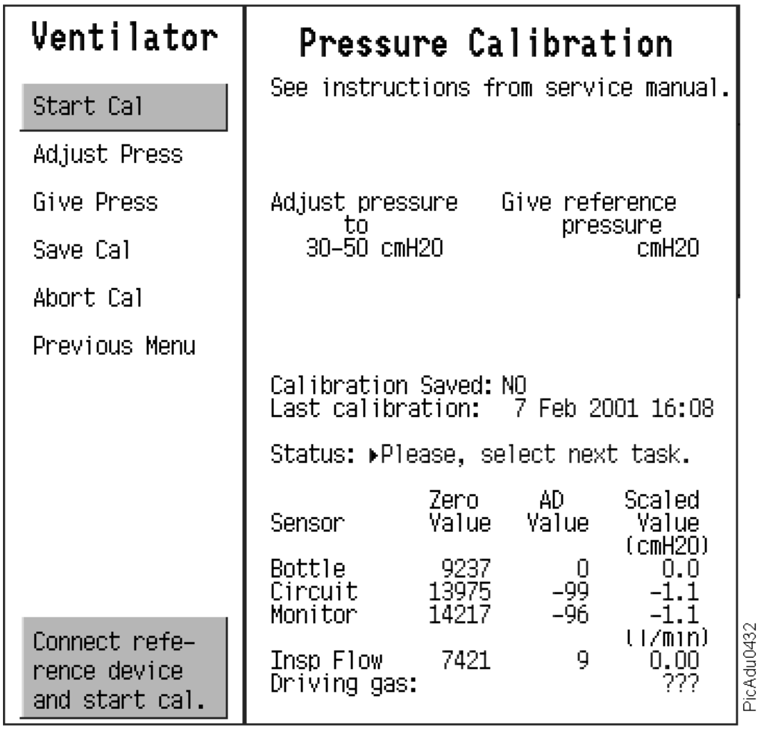


Figure 33 Pressure sensors calibration

1. Select low pressure range 0-250 cmH_2O on the test device.
2. Zero the test device. The reading should be 0.0.
3. Remove the bellows and refit the bellows chamber.
4. Connect the Y-piece of patient circuit to the test device's low pressure inlet.
5. Push the **Setup** key. Select ***Service*** and enter the calibration password. Select ***Calibrations - Ventilator - Pressure***.



```
Pressure Calibration
See instructions from service manual.

Adjust pressure   Give reference
      to               pressure
  30-50 cmH2O                 cmH2O

Calibration Saved: NO
Last calibration:   7 Feb 2001 16:08

Status: ▸Please, select next task.

             Zero     AD     Scaled
Sensor       Value   Value    Value
                             (cmH2O)
Bottle        9237       0      0.0
Circuit      13975     -99     -1.1
Monitor      14217     -96     -1.1
                             (l/min)
Insp Flow     7421       9     0.00
Driving gas:                    ???
```

Figure 34 Calibration - Ventilator - Pressure page

6. Start the calibration by selecting ***Start Cal***.

Status:

- Closing expiration valve 1
- Closing expiration valve 2.
- Closing support valve.
- Zeroing bottle sensor.
- Zeroing circuit sensor.
- Zeroing monitor sensor.
- Zeroing flow sensor.
- Turn the Auto/Man. switch to Auto position.

7. Select ***Adjust press***. Adjust the pressure carefully by open and closing the O_2 or air flow needle valve until the test device shows 30-50 cmH_2O. Let pressure stabilize for one minute.
8. Enter the reference pressure by selecting ***Give press*** and turning the **ComWheel**. Push the **ComWheel** when the given pressure corresponds to the pressure on the test device display.
9. Save the calibration by selecting ***Save Cal***. To abort calibration, select ***Abort Cal***. Refit the bellows and remove the test equipment.
10. Select ***Previous menu***. Perform the calibration according to the calibration tree.

PEEP calibration

This procedure calibrates the PEEP proportional valve. The calibration finds the valve setting for four expiration pressures: 5, 8, 15 and 40 cmH_2O. The calibration values are saved into EEPROM position 9, 10 and 11.

Settings: *ADU On*

Pipeline gases connected

No gas flows

VCV mode

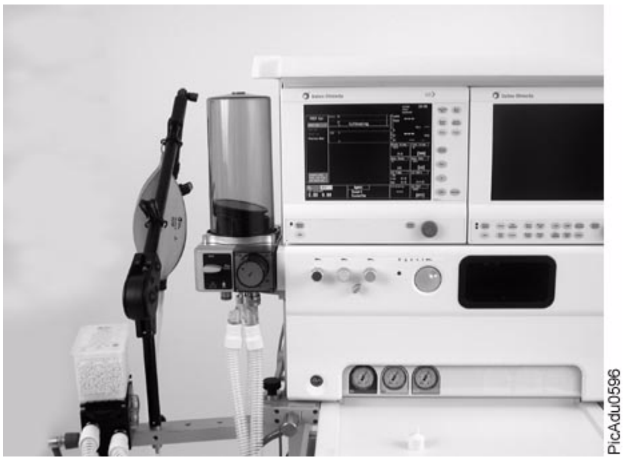
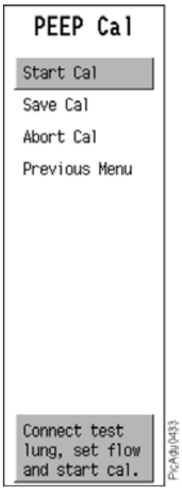


Figure 35 PEEP calibration setup

1. Turn Auto/Man. switch to the Man. position.
2. Occlude the Y-piece. Do not connect the test lung even if the help text menu say so.
3. Push ***Setup*** key. Select ***Service*** and enter the calibration password. Select ***Calibration - Ventilator - PEEP.***
4. Open the fresh gas flows to 2-4 l/min.



Connect test lung, set flow and start cal.

Figure 36 The Calibration - Ventilator - Peep page

5. Start the calibration by selecting ***Start Cal***. Turn the Auto/Man. switch to Auto position. Push O_2 flush until the bellows is in top position.

Displayed message: ‘Calibrating PEEP’

NOTE: This calibration may take up to 3 minutes. If nothing happens or the calibration fails - abort the procedure and check that the breathing circuit is in good condition. Restart the calibration.

6. When the message ‘PEEP CALIBRATION OK’ is displayed, Save the calibration by selecting ***Save Cal*** or abort the calibration by selecting ***Abort Cal***. If the message ‘PEEP CALIBRATION FAILED’ is displayed, abort the calibration by selecting ***Abort Cal***.
7. Select ***Previous menu***. Perform the calibration according to the calibration tree.

Inlet pressure regulator adjustment

This adjustment is to set the ventilator operation pressure.

Equipment needed:	*Pressure test device* *Pressure connector (735096)*
Tools:	*Wrench* *Cross-head (Pozidriv) screwdriver*
Settings	*Pipeline gases connected* *Manual mode*

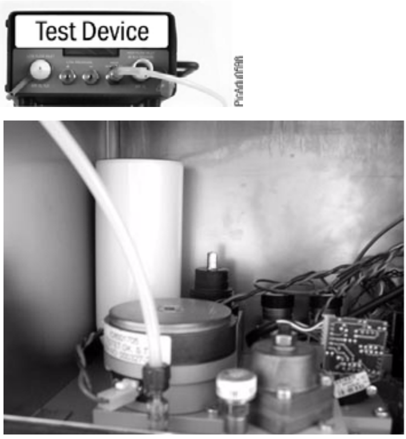
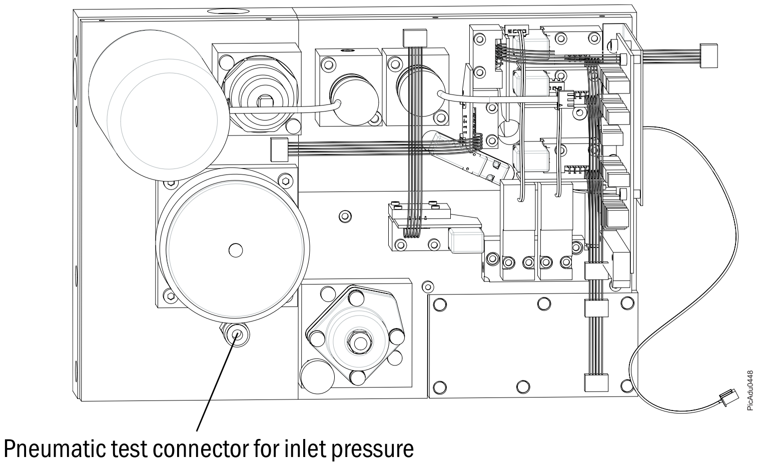


Figure 37 Inlet pressure regulator adjustment

1. Enter P+ high range function on the test device keypad.
2. Remove the ADU back plastic cover (10 Allen screws) and open the rear cover of the Ventilator (2 screws) Open and connect the pressure connector with a tube between the test device positive high range and the test connection, see Figure 38 on page C-46.



Pneumatic test connector for inlet pressure

Figure 38 Rear part of the Electronic Ventilator uncovered

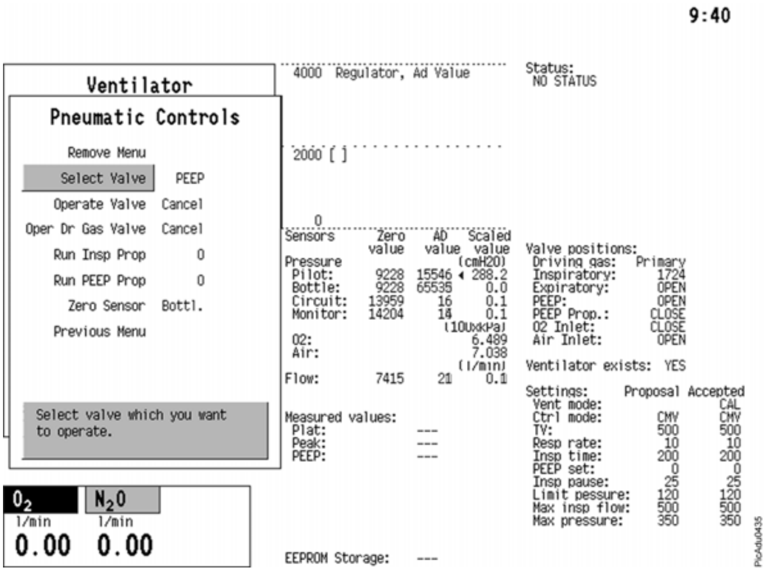
3. Turn on the ADU and bypass the System Check.
4. If an adjustment is necessary, adjust the inlet regulator item to 2.7 bar ±0.1. (39.16 psi ±1.45). Clockwise adjustment increases while counter-clockwise adjustment decreases the press.
5. Refit the cover and perform the needed calibrations according to the calibration tree.

Pilot pressure regulator adjustment

This pilot pressure regulator adjustment applies only to Ventilators with software version 7.6 or higher.

Equipment needed:	*Wrench 10 mm* *Allen wrench 3 mm*
Settings:	*ADU On* *Pipeline gases connected*

1. Push the **Setup** key. Select ***Service*** and enter the Diagnostics or Calibration Password.
2. Select ***Diagnostics - Ventilator - Pneumatics Controls - Select valve***



```
                                                                            9:40

 Ventilator                 4000  Regulator, Ad Value          Status:
  Pneumatic Controls                                            NO STATUS

        Remove Menu
        Select Valve   PEEP  2000 [ ]
        Operate Valve  Cancel
   Oper Dr Gas Valve   Cancel 0
        Run Insp Prop       0 Sensors       Zero     AD   Scaled
        Run PEEP Prop       0               value  value   value   Valve positions:
        Zero Sensor    Bottl. Pressure                   (cmH20)    Driving gas:   Primary
        Previous Menu          Pilot:       9228  15546 ◂ 288.2     Inspiratory:      1724
                               Bottle:      9228  65535     0.0     Expiratory:       OPEN
                               Circuit:    13959     16     0.1     PEEP:             OPEN
                               Monitor:    14204     14     0.1     PEEP Prop.:      CLOSE
                                                        (10UxkPa)   02 Inlet:        CLOSE
                               02:                        6.489     Air Inlet:        OPEN
                               Air:                       7.038
                                                        (l/min)    Ventilator exists:  YES
                               Flow:        7415     21     0.1
                                                                   Settings:   Proposal Accepted
   Select valve which you want                                      Vent mode:             CAL
   to operate.                 Measured values:                     Ctrl mode:       CMV   CMV
                                Plat:               ---             TV:              500   500
                                Peak:               ---             Resp rate:        10    10
                                PEEP:               ---             Insp time:       200   200
                                                                    PEEP set:          0     0
 O2      N2O                                                        Insp pause:       25    25
 l/min   l/min                                                      Limit pessure:   120   120
 0.00    0.00                                                       Max insp flow:   500   500
                               EEPROM Storage:   ---                Max pressure:    350   350
```

Figure 39 Diagnostics - Ventilator page

3. Select valve MUX.
4. Operate MUX valve to close position. This will make it possible to see the Pilot pressure value on the diagnostic page.
5. Select Run PEEP Prop and adjust it to digital value "3320" with the ComWheel
6. The Pilot Pressure (scaled value for pilot pressure) shall be between to 265-295cmH_2O. If the values are in limits is no adjustment necessary.
7. If an adjustment is necessary remove the ADU back plastic cover (10 Allen screws) and open the rear cover of the ventilator (2 Pozidriv screws).
8. Open the nut locking the 3 mm adjustment screw on the regulator. Adjust the pilot pressure regulator to 280 cmH_2O. Clockwise adjustment increases while counter clockwise decreases the pilot pressure. Retighten the nut and check that the set pilot pressure is between 265-295 cmH_2O. If not, repeat the adjustment procedure until the pilot pressure is within the limits.

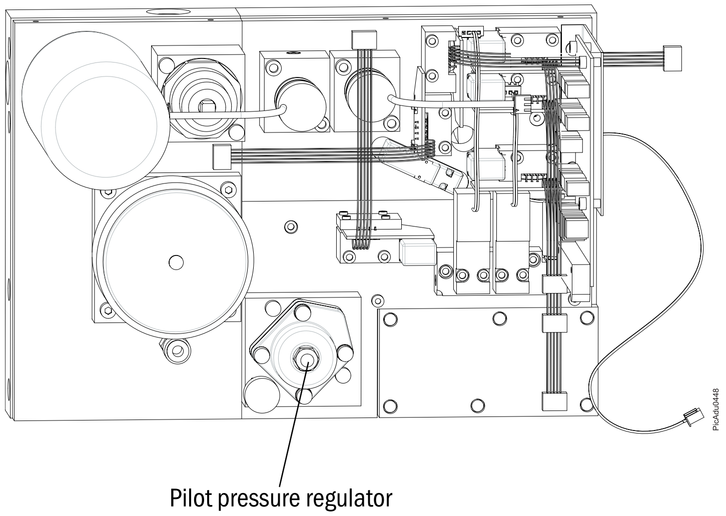


Figure 40 **Pilot pressure regulator**

9. When the pilot pressure is within the limits, turn off the ADU and after 10 seconds on again. Check that status message ‘Pilot press err’ (Main Software below version 7.0 and 6.0: ‘Low pilot press’) or not is displayed in the status field on the diagnostic page.
10. Refit all the covers in reversed order and turn the ADU off.
11. Turn on the ADU and perform the needed calibrations according to the calibration tree is the Technical Reference Manual.

TROUBLESHOOTING A-EV1

Ventilator error messages

Message in Normal Screen	Message in diagnostic page	Error condition / possible cause	Recommended action	Err log
P_{max} Release	Relief action	Pressure limit has been reached during inspiration	Check Alarm settings and be sure that limit is correct and there is no obstruction in tubes	
Fill bellows	Bellows at bott.	There is too little fresh gas flow or a leak in the patient system	Increase flow and check for leaks	
Driving gas to secondary	2nd driving gas	Primary gas is lost - uses secondary gas	Check pipeline and cylinder supply pressure. Check O_2 and air pressure sensor calibration.	x
-	Calib. data err	Given calibration data is not valid or the sensor is out of order	Check given value and try again. If it does not work, check the sensor and replace it if necessary	
Calibrate Ventilator	Factory default	Calibration data is lost or the CPU board and/or EEPROM is new	Calibrate device	x
-	Hw reset	There has been a system breakdown during the case	Replace CPU board	
Pause added		The settings have kept the ventilator inspiration flow below the limit. Extra pause is added.	N/A	
Ppeak High (AUTO & MANUAL)	N/A	Obstruction in the patient circuit or endotracheal tube.	4. Clear obstruction. 5. Check alarm settings.	
Ppeak Low (AUTO)	N/A	Disconnected or leaking hose or Ppeak low limit too high.	1. Check hose and connections. 2. Perform System checkout. 3. Check alarm settings.	

Message in Normal Screen	Message in diagnostic page	Error condition / possible cause	Recommended action	Err log
PEEP High (AUTO & MANUAL)	N/A	Sustained pressure. Scavenging system obstructed or overflow valve stuck.	1. Check scavenging system. 2. Check overflow valve in bellows block. 3. Check alarm settings	
Negative Pressure (AUTO & MANUAL)	N/A	Scavenging system malfunction (leak). Spontaneous breathing.	1. Check scavenging system. 2. Check pressure sensors.	
Loss of driving pressure	Multiple of alarms.	Neither primary nor secondary driving gas available. Ventilator inoperable.	Check gas supplies to ADU.	
O_2 supply pressure lost	O_2 supply pressure low	When the pressure does not reach the minimum pressure limit of 2.5bar.	1. Check gas supplies. 2. Check O_2 pressure sensor calibration.	
Air supply pressure lost	Air supply pressure low	When the pressure does not reach the minimum pressure limit of 2.5bar.	Check gas supplies. Check air pressure sensor calibration.	
Sigh cycle	N/A	Starting sigh cycle.	None. Notification to user.	
Select MAN or AUTO mode	Man/mech error.	The Auto/Man. switch is in neither position.	Check Auto/Man. switch. Replace Bellows block.	
Switch to MAN mode	N/A	System is in Auto mode after System Checkout. To prevent the ADU from starting to ventilate immediately it is required that user switches to Manual mode first.	Switch to manual ventilation.	
Cannot reach PCV pressure	N/A	Pressure limit not reached during five consecutive breaths.	Check for disconnection or some other malfunction that would cause a major leakage.	

Message in Normal Screen	**Message in diagnostic page**	**Error condition / possible cause**	**Recommended action**	**Err log**
Cannot deliver set vol.	Tv not deliv	The set tidal volume is such, that in the current situation, the ventilator is unable to deliver the complete volume	If this occurs in every breath - Check the settings. If about 1400 ml, increase the fresh gas flow	
	EEPROM R/W error	System is unable to use permanent memory	Replace EEPROM and calibrate A-EV1	x
	Zero ONE error	Zeroing is interrupted	No action needed	x
	Leak in circuit	Bellows chamber not correctly attached and the Auto/Man. switch in Auto position. Or big leak in patient circuit.	Check bellows bottom plate gasket- Check Bellows chamber locking mechanism and gasket for chamber correct installed. Try with other Bellows block.	
	Zero TWO error	Zeroing is interrupted	No action needed	x
	Power failure	One or more module power supply voltages are outside limits	Find out which voltage is out of range.	x
	A/D converter	AD device has failed or flow sensor is out of range	Replace CPU board / or check flow sensor	x
	Software error	Internal software check	Replace the ventilator software. Replace the CPU board.	x
	Zeroing	A-EV1 performs sensor zeroing	N/A	
	Ref. voltage	Broken components on CPU board	Replace CPU board	x
	Compliance err	Measured compliance outside its limits (10 ml/cmH_2O)	Check patient circuit	x
Sigh cycle	Sigh cycle	A-EV1 performs sigh cycle	N/A	

Message in Normal Screen	**Message in diagnostic page**	**Error condition / possible cause**	**Recommended action**	**Err log**
Select MAN or AUTO mode	Man/mech error	Auto/Man switches are in wrong position or micro switches are faulty	Open the Auto/Man. switch assembly and test the micro switches. Replace faulty switches.	
	flow comparr error	Too low inlet pressure or pressure regulator set below 2.7 bar	Check the pipeline supply pressure. regulator. Last flow calibration was done with too low or fluctuating pipeline pressure. Action: calibrate flow calibration.	
	flow range error	Unit Stays in Self-Test	Check the pipeline supply pressure. Calibrate the ventilator flow sensor. Check on Ventilator Diagnostic page: Open the Inspiratory proportional valve full open. Check that the inspiration flow is >80 l/min. If less than 80 l/min. check can it be a restriction in the O_2 or air valve (the one set-up as drive gas).	
	Insp flow err	Unit Stays in Self-Test	Inspiration valve can not close: - faulty Inpiration proportional valve - last flow calibration wrong done	
Loss of driving pressure	Missing driv pre	Missing driving pressure Driving pressure < 250 kPa	Check the drive gas supply pressure	

Message in Normal Screen	Message in diagnostic page	Error condition / possible cause	Recommended action	Err log
Ventilator communication error	N/A	Ventilator communication broken with the A-ELEC module. Beware of the Ventilator communication error alarm will be a sub alarm to Ventilator failure alarm.	If alarm is single check communication cable between the A-EV1 and A-ELEC. Replace Digipower board A-ELEC or Ventilator CPU board.	
	pilot press err "Low pilot press". On units with Main SW <6.1 SW	During the A-EV1 Self-test was the pilot pressure outside the specification range of 270 – 330 cmH_2O. Note: this range only applies to Ventilator software version 7.6 and onwards.	Calibrate pilot pressure regulator. Check pipeline gas supply pressure.	
Ventilator * failure	Sensor error	Zero point out of range Underflow or overflow of sensor.	Replace sensor or zeroing valve	x
Ventilator * failure	Press Compar err	Comparison error between circuit and monitoring pressure sensors	Check the circuit and monitor sensor calibration and replace if needed	
Ventilator * failure	Inspiration valve	Inspiration valve has not closed when expiration starts	Replace valve	x
Ventilator * failure	Expiration valve	PEEP valve does not open quickly enough	Replace valve or membrane	x
Ventilator * failure	Expir valve 2	Expiration valve does not open quickly enough	Replace valve or membrane	
Ventilator * failure	EEPROM error	Calibration data lost or broken CPU board	Replace EEPROM and recalibrate. Note that this always happens when a new EEPROM is started for the first time	x
Ventilator * failure	AUTO/ MAN switch	Mode evaluated from both micro switches	N/A	

Message in Normal Screen	Message in diagnostic page	Error condition / possible cause	Recommended action	Err log
Ventilator * failure	HW watchdog err	HW watchdog circuit does not reset system during internal system check	Replace CPU board	x
Ventilator * failure	ROM check sum	Program memory is faulty	Replace program or replace CPU board	x
Ventilator * failure	RAM W/R error	Faulty components on CPU board	Replace CPU board	x
Ventilator * failure	Hw reset	Unexpected reset of CPU	Replace CPU board	
Ventilator * failure	Flow zero-error	Failed test of flow zeroing valve	Replace flow sensor or zeroing valve	
Ventilator * failure	Backup CPU Error	Failed test of backup CPU	Replace CPU board	
Ventilator * failure	pilot press err	During the A-EV1 Self-test was the pilot pressure below 120cmH_2O.	Calibrate pilot pressure regulator. Check pipeline gas supply pressure. Replace pilot pressure regulator	x

*) Check also Ventilator failure alarm troubleshooting guide for reason for ventilator failure alarm. Beware of the O_2 supply lost alarm and the ventilator communication alarm will go off as a consequent of a ventilator failure alarm.

Ventilator failure alarm troubleshooting guide

The suggested actions below should be seen as a starting point when a intermittent Ventilator failure alarm has occurred, this means that an sensor error for example can be due to a broken CPU board or DC/DC board.

The reason for a ventilator failure (Safe State) is stored in the Ventilator EEPROM. In position 15 an ID is stored and in position 16 to 19 some extra information is stored. All values are stored in hexadecimal format.

Beware of as long the Ventilator failure alarm is present, can not the correct data be presented from the EEPROM on the A-EV1 Diagnostic page. This because the communication between A-ELEC and A-EV1 not are working correctly (this is also the reason to that the O_2 supply lost alarm and Ventilator communication error alarm comes as sub alarms to the Ventilator failure alarm).

To check the EEPROM values on a failing ADU with a Ventilator failure alarm must the ADU be restarted and no Ventilator failure alarm be present.

If the alarm is present should the fault be traced by entering the A-EV1 diagnostic page and performing the trouble shooting from the messages found under STATUS in the diagnostic page.

Note: A-EV1 with software version 7.5 or later will the failures be stored until next Ventilator failure, this means after a Full System check will the information remain, which not was the case before.

EEPROM Value at index 15	**Failure type**	**Information on Diagnostic Page Status**	**Saved in Service Log**
13	1	Backup CPU error	No
14	2	Sensor error	Yes
15	3	Flow zero Error	No
17	4	Insp valve	Yes
18	5	Expiration valve	Yes
19	6	Expir Valve 2	No
1F	7	EEPROM error	Yes
21	8	HW reset	No
26	9	ROM checksum	Yes
27	10	RAM W/R error	Yes
28	11	HW watchdog error	Yes
29	12	Sensor error	Yes
2D	13	ROM checksum	Yes
31	14	Pressure comp err.	No
64	15	None	No
65	16	None	No
10	17	Pilot press err (Low pilot press)	No

Failure type 1 **Backup CPU error**	
EEPROM values	
Index	**Value**
15	13
16	Start flow for backup CPU test
17	End flow for backup CPU test
18	0 (not used)
19	0 (not used)
Reason: Backup processor fails during self-check test. The test checks that the backup CPU is able to close the inspiration valve fast enough.	
Suggested action: Change CPU board in A-EV1.	

Failure type 2 **Sensor error, Case 1**	
EEPROM values	
Index	**Value**
15	14
16	11 (INSP_FLOW_ERR)
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: Flow sensor value is too high at start-up. The ventilator is measuring a constantly high flow through the machine even when the inspiration valve is closed (= current 0 to valve).	
Suggested action: Start the machine and check if there is a constant flow in the machine. If this is the case: change the inspiration valve, otherwise change the flow sensor board.	

Failure type 2 Sensor error, Case 2	
EEPROM values	
Index	**Value**
15	14
16	66 (ID_MAIN_WD)
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: A-EV1 SW has stopped in an eternal loop.	
Suggested action: Change to latest A-EV1 software.	

Failure type 2 Sensor error, Case 3	
EEPROM values	
Index	**Value**
15	14
16	A (ADC_RANGE_ERR)
17	ADC value
18	error channel
1	Monitor pressure
2	Bottle pressure
3	Patient pressure
4	Flow
19	0 (not used)
Reason: A sensor value is out of range. Compare with case 4 below.	
Suggested action: Change the pressure sensor board for the failing sensor.	

<table>
<tr><th colspan="2">Failure type 2
Sensor error, Case 4</th></tr>
<tr><td colspan="2">EEPROM values</td></tr>
<tr><td>Index</td><td>Value</td></tr>
<tr><td>15</td><td>14</td></tr>
<tr><td>16</td><td>A</td></tr>
<tr><td>17</td><td>air ad-value</td></tr>
<tr><td>18</td><td>oxygen ad-value</td></tr>
<tr><td>19</td><td>0 (not used)</td></tr>
<tr><td colspan="2">Reason:
At start-up the oxygen or air wall pressure sensors is out of range. Compare this with case 3</td></tr>
<tr><td colspan="2">Suggested action:
Low limit (= below): 64
High limit (= above): 7F58
Change the pressure sensor board that is out of range.</td></tr>
</table>

<table>
<tr><th colspan="2">Failure type 3
Flow Zero error</th></tr>
<tr><td colspan="2">EEPROM values</td></tr>
<tr><td>Index</td><td>Value</td></tr>
<tr><td>15</td><td>5</td></tr>
<tr><td>16</td><td>actual flow</td></tr>
<tr><td>17</td><td>start flow</td></tr>
<tr><td>18</td><td>0 (not used)</td></tr>
<tr><td>19</td><td>0 (not used)</td></tr>
<tr><td colspan="2">Reason:
Start-up test (= self test) of flow zeroing valve has failed. Flow is not reduced fast enough when switching the flow-zeroing valve.</td></tr>
<tr><td colspan="2">Suggested action:
Change flow-zeroing valve.</td></tr>
</table>

Failure type 4 **Inspiration valve error**	
EEPROM values	
Index	**Value**
15	7
16	maximum flow
17	current flow
18	0 (not used)
19	0 (not used)
Reason: Inspiration valve stays in open position after giving a command to close it.	
Suggested action: Change inspiration valve	

Failure type 5 **Expiration valve error (peep Pilot valve)**	
EEPROM values	
Index	**Value**
15	8
16	Limit pressure
17	Actual pressure
18	0 (not used
19	0 (not used
Reason: During start-up test (= self-check), Pressure is not decreasing fast enough when peep valve is opened.	
Suggested action: Change peep pilot valve.	

<table>
<tr><th colspan="2">Failure type 6
Expiration valve 2 error (exp Pilot valve)</th></tr>
<tr><td colspan="2">EEPROM values</td></tr>
<tr><td>Index</td><td>Value</td></tr>
<tr><td>15</td><td>9</td></tr>
<tr><td>16</td><td>Limit pressure</td></tr>
<tr><td>17</td><td>Actual pressure</td></tr>
<tr><td>18</td><td>0 (not used)</td></tr>
<tr><td>19</td><td>0 (not used</td></tr>
<tr><td colspan="2">Reason:
During start-up test (= self-check), Pressure is not decreasing fast enough when expiration valve is opened.</td></tr>
<tr><td colspan="2">Suggested action:
Change expiration pilot valve</td></tr>
</table>

<table>
<tr><th colspan="2">Failure type 7
EEPROM_ERROR, Case 1</th></tr>
<tr><td colspan="2">EEPROM values</td></tr>
<tr><td>Index</td><td>Value</td></tr>
<tr><td>15</td><td>1F</td></tr>
<tr><td>16</td><td>1</td></tr>
<tr><td>17</td><td>E_TBY1 (default 18)</td></tr>
<tr><td>18</td><td>E_TBY3 (default 7)</td></tr>
<tr><td>19</td><td>0 (not used)</td></tr>
<tr><td colspan="2">Reason:
Data has been corrupted in EEPROM.</td></tr>
<tr><td colspan="2">Suggested action:
Change EEPROM.</td></tr>
</table>

Failure type 7 EEPROM_ERROR, Case 2	
EEPROM values	
Index	**Value**
15	1F
16	2
17	read checksum
18	written checksum
19	0 (not used)
Reason: Error when writing checksum	
Suggested action: Change EEPROM.	

Failure type 7 EEPROM_ERROR, Case 3	
EEPROM values	
Index	**Value**
15	1F
16	4 or 8
17	read word
18	written word
19	0 (not used
Reason: Error when writing into EEPROM	
Suggested action: Change EEPROM.	

Failure type 8 Reset error	
EEPROM values	
Index	**Value**
15	21
16	F1
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: CPU reset during operation. This may be caused by a disturbance of the DC/DC converter. This can also be the result of a very short off time when restarting the machine.	
Suggested action: If this happened when the machine was switched off and than back on immediately there is nothing to worry about. Just wait a couple of second's before restarting it and everything will work fine! If problems occur during normal run replace DC/DC converter or A-EV1 CPU board.	

Failure type 9 ROM_ERR	
EEPROM values	
Index	**Value**
15	26
16	error code
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: During start-up test (= self-check), Something wrong in program memory device, bank 1	
Suggested action: Change program memory device = A-EV1 software.	

Failure type 10 RAM_ERR	
EEPROM values	
Index	**Value**
15	27
16	error code
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: During start-up test (= self-check), RAM has not passed read/write test.	
Suggested action: Change A-EV1 CPU board.	

Failure type 11 HW_DOG_ERR	
EEPROM values	
Index	**Value**
15	28
16	watchdog value
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: During start-up test (= self-check), Watchdog circuit failed initial test	
Suggested action: Change A-EV1 CPU board	

Failure type 12 **Zeroing error**	
EEPROM values	
Index	**Value**
15	29
16	D of sensor
1	monitor
2	bottle
3	circuit
4	flow difference
17	measured zero value.
18	0 (not valid)
19	0 (not valid)
Reason: The zero-value is out of range for a pressure sensor board.	
Suggested action: Change the failing pressure sensor board	

Failure type 13 **ROM_ERR_2**	
EEPROM values	
Index	**Value**
15	2D
16	error code
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: Something wrong in program memory device (A-EV1 software), bank 2.	
Suggested action: Replace A-EV1 SW with latest version.	

Failure type 14 **Pressure comparison error**	
EEPROM values	
Index	**Value**
15	31
16	difference
17	monitor pressure
18	last difference.
19	0 (not used)
Reason: Pressure measured from monitor and circuit sensor board differs too much	
Suggested action: Test the pressure sensor boards with an external reference. Test Zeroing valve function. Change the failing zeroing valve or complete sensor board. If no problem is found both pressure sensor boards has too be changed.	

Failure type 15 **D_GENTIME**	
EEPROM values	
Index	**Value**
15	64
16	1 or 2
17	function pointer
18	0 (not used
19	0 (not used
Reason: SW timer routine is failing	
Suggested action: Replace A-EV1 SW with latest version.	

Failure type 16 **D_RECEIVE**	
EEPROM values	
Index	**Value**
15	65
16	67 or 79
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: External command to enter safe state	
Suggested action: Change to latest SW in A-ELEC	

Failure type 17 **Pilot press err.**	
EEPROM values	
Index	**Value**
15	10
16	< 4b0
17	0 (not used)
18	0 (not used)
19	0 (not used)
Reason: The pilot pressure is measured during the self-test was below 120 cmH_2O. is regulated to a lower limit of 75–85 cmH_2O. This can result in improper function of the expiration valve membranes in the PCV mode.	
Suggested action:	

Other problems

Fault	Possible cause	Action
Ventilator stays in Self-test	No primary gas connected. Bellows chamber not correctly attached. Bellows block not locked. Bellows block gasket missing or worn out. Check the chamber gasket as well as the overflow valve Broken fuse (the one that controls valve voltage). Broken inspiration valve, pilot valve, pilot pressure regulator. Big leak in driving gas side tube, expiration valve, expiration valve control. Zeroing valve error in flow measuring unit.	Go to A-EV1 diagnostic page and check messages under status:
Ventilator stays in Self-test after flow ventilator flow calibration.	Completely wrong Ventilator flow calibration have been performed. Message on diagnostic page can be "flow range error" "Insp flow error"	Repeat calibration and make sure the Ventilator is in CAL mode
No ventilation and no "Tidal volume not delivered" alarm. (The bellows does not move or the movement is small compared to the set volume and the fresh gas flow is relatively small.)	Expiration valve is leaking. Leak in driving gas side.	Perform a System Check and if not passed, Check error stored in the system checkout error log. Go then to System check trouble shooting guide.
Pressure rises when pressurised although fresh gas flow is zero.	Inspiration valve leaks into circuit	Go to A-EV1 diagnostic page and check messages under status:
Alarm message: - PEEP high and level unstable (rises with no of breaths). System Status Messages: - Fill bellows - Can not reach PCV pressure. System check - Compliance error in Auto Leak test.	Restrictor in the Bellows block may be blocked. Ventilator driving gas does not reach the top of the overflow valve. Beware of that not all A-BB have the restrictor.	Remove Bellows chamber and Bellows. Inspect restrictor occlusion. The restrictor is it placed in the gas channel going from the chamber to the top of the overflow valve. Clean restrictor or replace restrictor.

In VCV mode with a set PEEP it may be observed that the pressure curve has an extra pressure rise just before the expiration phase starts (see figure below). If the pressure rise is above 1cmH_2O will the problem be treated by:

1. Check that the expiration valve unit membrane suffices side (the side against the seat) is dry and without any grease. If the membranes feels little sticky can lime be rubbed in on the membranes surfaces. After this should the membrane surfaces be bleed with air to remove all loose particles from the lime. Reinstall the membranes to the expiration valve unit and calibrated the PEEP following up with System Checkout.
2. Replace the membranes in the expiration valve unit and calibrated the PEEP following up with System Checkout.

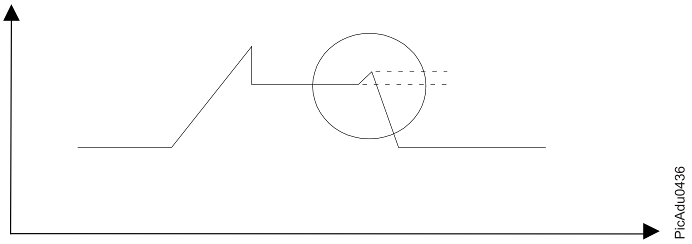


Figure 41 **Pressure curve**

Description of ventilator self test

Electronics checks

When the ventilator starts working, the start-up code is executed. The code consists of checks and initialisations.

Before any tests, there is a check if the ADU has been reset or properly switched on. If there has been a reset, a program sets the unit in a safe state, immediately indicated by the alarm ‘Ventilator failure’.

If the ADU has been properly switched on, the operation of the most important electronic components is checked.

Before any commands are accepted, the software version is checked between the main CPU and the ventilator. Without the correct handshake, the system goes into safe state.

The electronics checks in order

1. HW-watchdog check
2. memory read and write check
3. program check sum
4. EEPROM value check
5. Memory is zeroed and interrupts initialized.
6. Valve exercise

The zeroing valves and both expiration valves has been implemented at start-up of the Ventilator to increase the robustness of the self-test. The reason for this is that if an ADU has been out of use for a prolonged period of time, there is a risk for sticking valves that can cause start-up problems of the Ventilator during the self-test.

Exercising the zeroing valves will cause a rapid audible clicking sound during self-test. This distinguishes version 7.6 from prior versions of software. Although it may seem unusual at first, it is not a fault. The new self-test will take a total time of 70 seconds to execute.

If the communication with the Main software is working correctly, the A-EV1 proceeds into the next phase of the Self-Test. The message Self-Test is the displayed on the ADU display and following components and routine are executed automatically:

NOTE: The Self-Test can be initiated separately on the ventilator diagnostic page.

Wall pressure checks

Wall pressures are checked by:

- Closing both supply valves.
- Letting out the all gas through the inspiratory valve.
- Opening the secondary driving gas supply and letting some gas out

After this the primary drive gas is selected and the self-check proceeds to calibration of the inspiration valve. If the primary drive gas is missing, it is noticed in the beginning of the inspiration calibration.

Acceptance limit: >2.5 bars.

Inspiration valve calibration and verification

Inspiration valve is calibrated in seven points during the Self-Test. Calibration is verified in the middle of calibration points. Information from these checks ensures that inspiratory valve is operating correctly.

The calibration is verified in halfway through the calibration to ensure that the inspiratory valve is operating correctly.

The system should be able to deliver a flow of 80 l/min. Otherwise the check fails.

Backup CPU check

In this check, the inspiratory valve is opened and a message that the backup CPU check is on, is sent to the MAIN interface. The message should be echoed back so that the backup CPU gets the information. The backup CPU should close the inspiratory valve. The check is accepted if the valve is closed and the inspiratory flow is cut.

Expiratory valves check

The inspiratory valve is opened and the expiratory valves (PEEP and EXP.) are closed. The expiratory valves (PEEP and EXP.) are opened one after another. The pressure inside the ventilator should go down within a specified time.

(100*abs(ref_flow-flow)/ref_flow < acceptance)

Flow sensor zero valve check

The Insp. valve is opened to approx. 25 l/min. and the flow is measured. The Insp. valve is kept open and the zero valve is opened. The flow, which should be close to zero, is measured.

Flow sensor check

The Insp. valve is opened to approx. 25 l/min. and the flow is measured. The flow is also calculated according to the position of the proportional valve (reference calibration). These two flows should be close to each other. The accepted difference is ± 20%.

Pilot pressure level check

The pilot pressure is measured at start-up, as it requires switching the MUX valve away from the chamber. The pilot pressure is measured and if it is outside the specifications, a status message ‘Pilot press err’ (‘Low pilot press’) is triggered. The message appears on the ***Service - Diagnostic*** page’s status field. Accepted range is 250-310 cmH$_2$O.

System checkout troubleshooting guide

If the Manual or Auto mode leak tests fails, the failure reason including the %failure number will be stored in the ***System Check - Check Log - Error History*** page to give a better technical description of the error that have been logged.

Manual mode leak test

error/ % no	**Technical reason**		**Possible cause** **Suggested action**
Ppeak = Pressure errors			
5	Ppat >125 mmH$_2$O	To high pressure. APL valve not closed properly.	- An extra pressure peak is detected during the test (may have been caused accidentally while handling the respiratory tubing or open a flow control.) -The pressure was higher than 20 cmH$_2$O at the start of the Manual Leak test. Open APL valve to decrease the pressure before adjusting it to 80 cmH$_2$O
56,66,76, 86		Pressure is rising in the system.	
98	Ppat (50 mmH2O) + 10 mmH$_2$O < Ppat(80)	Pressure has slowly increased.	
Leak = Leak errors			
25	Ppat < 200 mmH$_2$O and V(leak) > 6000 ml/sec	To low pressure because of leak.	- The manual APL valve is still open - The respiratory tubing and/or its connections are leaking - The manual ventilation bag is leaking - A gas monitor is connected to the circuit and is sampling gas. - Following Leak Tracing Chart for Auto Leak Test in the *“Technical Reference Manual”.*
26	Ppat < 200 mmH$_2$O and Ppat > 100 mmH$_2$O	Patient pressure is not enough after 60 seconds.	
55,65,75, 85	Ppat < ¾ Pmax	Big leak in the system. Pressure is below ¾ of max pressure.	
94	Ppat (50 mmH2O) > Pat (80 mmH2O) + 50 mmH2O	A small leak during a longer time.	
100	Leak > 150mmH2O	Leakage to large.	
Switch = Auto/Man. switch errors			
31,51,61, 71,81		Auto/Man. switch changed during test.	- The position of the Auto/Man. selector has been altered during the test. Repeat the test.
HiFlw = Fresh gas flow detection errors			

error/ % no	**Technical reason**		**Possible cause** **Suggested action**
52,62,71, 82	fgf > 2 l/min	Fresh gas flow detected.	The Fresh gas flows not property closed. Close flow controls and repeat the test.
TIMEO and FAIL = Interruptions and Timeout errors			
Any		Test taken to long or test has been interrupted by Main software.	Action Repeat test.
Discn = Disconnection errors			
27	Ppat <= 100mmH$_2$O	Not enough pressure after 60 seconds.	-

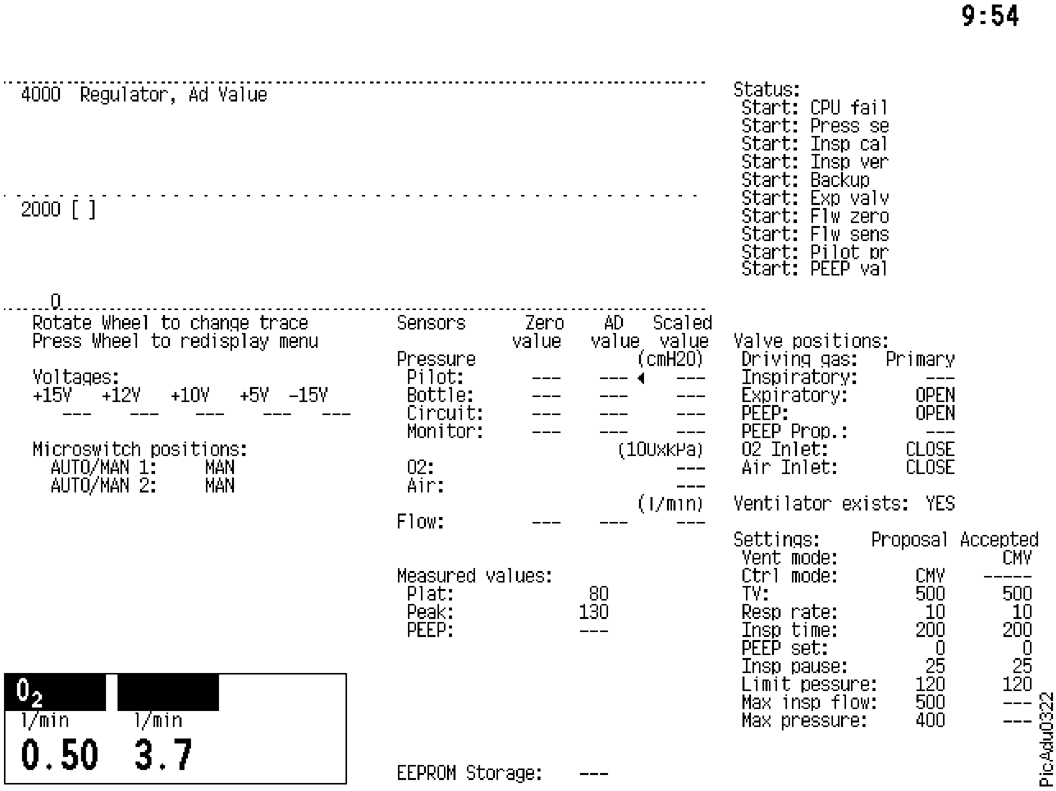
Auto mode leak test

error / % no	**Technical reason**		**Possible cause** **Suggested action**
Leak = Leak errors			
8	12 mmH$_2$O > Ppat > 21 mmH$_2$O	Bellows not filled during the start-up phase of the test. Pressure is not enough high after 15 sec.	- Leak in circuit tubing's. - Circuit tubing's bad connected. - Absorber leaks or wrong connected. - Insp. or exp. valve cover is leaking. - Bellows block or bellows chamber not locked correctly. - Bellows block chamber seal leaks - Overflow valve cap not tighten sufficiently. - Overflow valve or cap O-ring worn-out. - The Y-piece is not properly occluded. - Compact block leaking - Bellows not mounted correctly. - Check with other tubing's and bellows block. - Following Leak Tracing Chart for Auto Leak Test in the *“Technical Reference Manual”*.
13,33,53, 73	Ppat < 120 mmH$_2$O	Leak detected during one of the four measurement cycles. Minimum patient pressure.	
24,44,64, 84	Ppeak > Ppat + 100 mmH$_2$O	Leak detected during one of the four measurement cycles. Big leak, the pressure is lower than Ppeak – 100 mmH$_2$O.	
25,45,65, 85	Ppeak > Ppat + 75 mmH$_2$O	Leak detected during one of the four measurement cycles. Moderate leak, the pressure is lower than Ppeak – 75 mmH$_2$O.	
100	Leakage >150 ml/min.	Test have gone through the entire test but leakage bigger than 150ml/min.	

error / % no	**Technical reason**		**Possible cause** **Suggested action**
Coml = Compliance errors			
15,35,55, 75	compl < 1 ml/cmH$_2$O	Compliance error during one of the four measurement cycles. Measured compliance below lower limit.	- Big obstruction inside the bellows block. - Replace bellows block.
14,34,54, 74	Ppeak – Pendexp < 50 mmH$_2$O	Compliance error during one of the four measurement cycles. Pressure difference is too small for calculation of compliance.	- One or more components in the breathing circuit have too large compliance. - To long tubing's - Silicon tubing's are not recommended to use, it will increase the compliance in the system. - Check connections and tubing's. - Replace tubing's.
16,36,56, 76	compl > 10 ml/cmH$_2$O	Compliance error during one of the four measurement cycles. Measured compliance above higher limit.	
78	Pplatmax > Ppeak. The difference between the lowest and highest compliance is larger than 0.7 ml/cmH$_2$O.	Compliance error during one of the four measurement cycles. Big difference between the four compliance calculations.	
Discn = Disconnection errors			
4	Ppat > 12 mmH$_2$O	Bellows not filled during the start-up phase of the test. Pressure too low after 15 sec.	Big leak in circuit tubing's. - Circuit tubing's bad connected. - Absorber leaks or wrong connected. - Insp./exp. valves covers are not installed. - Gasket underneath bellows block is missing. - The Y-piece is not occluded or a patient bag is connected to it. - Overflow valve missing in bellows block. - Compact block have a big leak. - Fresh gas hose not connected between the compact block and fresh gas outlet. - No test flow is coming from the freshgas control unit / check the O$_2$ Test valve function. - Following Leak Tracing Chart for Auto Leak Test in the *"Technical Reference Manual"*.
17,37,57,77	Bottle > 170 mmH2O and Ppat < 120 mmH$_2$O	Disconnection during one of the four measurement cycles. To big difference between the bottle and circuit pressure.	
94	Ppat < 21 mmH$_2$O	Disconnection during one of the four measurement cycles. Bellows not filled after 10 sec.	
96	Ppat < 200 mmH$_2$O	Disconnection during the last fill-up cycle of the bellows. Pressure too low after 4 second.	

error / % no	**Technical reason**		**Possible cause Suggested action**
PPeak = Pressure errors			
12,32,53, 73	Ppat < 270 mmH$_2$O and Vol < 155ml.	Not reached pressure or volume after 6 seconds during the inspiration phase.	- Inspiration flow can not pressurize the bellows for some reason. Repeat test with another bellows block. - Inspiration valve has not open.
23,43,63, 83	Ppat(current) > Ppeak	Pressure error detected during one of the four measurement cycles. Pressure is rising in the system	An extra pressure peak is detected during the test. - Accidentally handling the respiratory tubing's during the test. - Flow controls not closed completely or have been open during the test. - Accidentally pushed the O$_2$ flush during the test.
26,46,66, 86	Pplatmax > Ppeak	Pressure error detected during one of the four measurement cycles. Pressure is rising in the system	
HiFlw = Flow errors			
22,42,62, 82	fgf > 2 l/min.	Fresh gas flow detected.	The flow controls have not been properly closed. Close flow controls.
Switch = Auto/Man. switch errors			
1,11,21,31, 41,51,61,71, 81,91		The position of the Auto/Man. selector has been altered during the check.	Turn the auto/man switch back and repeat the auto leak test.
TIMEO or FAIL = Interruptions and Time-out errors			
Any		Test taken to long or test has been interrupted by Main software.	Action Repeat test.

Ventilator diagnostic page layout



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                                                              9:54

 4000  Regulator, Ad Value

 2000 [ ]

    0
  Rotate Wheel to change trace
  Press Wheel to redisplay menu

  Voltages:
  +15V   +12V   +10V   +5V  -15V
     ---    ---    ---    ---   ---

  Microswitch positions:
    AUTO/MAN 1:     MAN
    AUTO/MAN 2:     MAN
```

```
Sensors      Zero    AD   Scaled
            value  value  value
Pressure                 (cmH2O)
 Pilot:       ---    --- ◀  ---
 Bottle:      ---    ---    ---
 Circuit:     ---    ---    ---
 Monitor:     ---    ---    ---
                        (10UxkPa)
 O2:                        ---
 Air:                       ---
                          (l/min)
Flow:         ---    ---    ---

Measured values:
 Plat:              80
 Peak:             130
 PEEP:             ---


EEPROM Storage:    ---
```

```
Status:
 Start: CPU fail
 Start: Press se
 Start: Insp cal
 Start: Insp ver
 Start: Backup
 Start: Exp valv
 Start: Flw zero
 Start: Flw sens
 Start: Pilot pr
 Start: PEEP val

Valve positions:
 Driving gas:   Primary
 Inspiratory:       ---
 Expiratory:       OPEN
 PEEP:             OPEN
 PEEP Prop.:        ---
 O2 Inlet:        CLOSE
 Air Inlet:       CLOSE

Ventilator exists:  YES

Settings:      Proposal Accepted
 Vent mode:                  CMV
 Ctrl mode:         CMV    -----
 TV:                500      500
 Resp rate:          10       10
 Insp time:         200      200
 PEEP set:            0        0
 Insp pause:         25       25
 Limit pessure:     120      120
 Max insp flow:     500      ---
 Max pressure:      400      ---
```

```
O2
l/min    l/min
0.50     3.7
```

Figure 42   Ventilator diagnostic page

Voltages

Voltages measured at:

+12 V (12.7-13.8 V) = Operating voltage for valve drivers

+10 V (9.8-10,2) = Operating voltage for pressure sensors

+5 V (4.75-5.25 V) = Operating voltage for digital electronics

-15 V (-14-(-17) V) = Operating voltage for analog electronics

Micro switch positions

AUTO/MAN 1: = Position of the micro switch in AUTO/MAN switch

AUTO/MAN 2: = Position of the micro switch in AUTO/MAN switch

Sensors

Pressure

Pilot: = Pressure measured at pilot regulator output

Note
To monitor the pilot pressure correctly the calibration instruction for pilot pressure should be followed. See the “A-EV1 calibration chapter”

Bottle: = Pressure in bellows chamber

Circuit: = Pressure measured at patient side

Monitor: = Pressure measured at patient side

O_2: = Oxygen supply pressure

Air: = Air supply pressure

Flow

flow measurement unit l/min.

Zero value, signal value in AD counts and scaled flow value in l/min. AD value = difference between zero value and scaled value (present sensor values.

Measured values

Pplat: = Pressure

Peak: Highest patient pressure

PEEP: Positive end expiratory pressure

EEPROM Storage: = Calibration factor stored in the EEPROM

Status message during self test

Press se = Pressure sensors zeroed

Insp cal = Inspiration valve calibration

Insp ver = Inspiration valve verification

Backup = Backup CPU test.

Exp valv = Expiration valve check

Flw zero = Flow sensor zeroing valve check

Flw sens = Flow sensor check

Pilot pr = Pilot pressure check

PEEP val = PEEP valve check

Status = messages

The ventilator self test can be initiated and the different checks will be Noted.

Failure messages are also shown here (see Trouble Shooting).

Valve positions

Driving gas: = Indicates if the A-EV1 uses primary or secondary gas as drive gas

Inspiratory: = Position of the Inspiration proportional valve

Expiratory: = Position of the EXP pilot valve

PEEP: = Position of the PEEP pilot valve

PEEP.Prop.: = Position of the PEEP proportional valve

O_2 Inlet: = Position of the O_2 valve.

Air Inlet: = Position of the Air valve.

Ventilator exist:

YES = Communication OK

NO: = Not working

Settings Proposal accepted

For R&D use.

Cursor

With the cursor can different parameter be selected to be shown I graphical form on the diagnostic page.

Leak tracing

The purpose of this section is to give help and information on problems with passing the leak tests in the System Check. Note that most problems are related to parts which are often handled and washed etc. The User's Reference Manual covers the most probable sources of leakages. If the advice in the User's Reference Manual are not enough to solve a leakage problem, the following charts and tests may be used for further tracing.

In the following three charts the theoretically possible sources of leakages are divided into several groups. Which chart to follow depends on whether the auto leak test or the manual leak test or both have failed. This is based on the assumption that there is one source of leakage. If there is a reason to suspect that there are several sources of leakage, the other two charts should also be taken into account.

Tests 1-3 in the charts, refer to service tests that are represented in "Ventilator test (Test 1)" on page C-80 through "Test for Bellows block and bottom plate leakage (Test 3)" on page C-81

These tests cover the areas and details represented in the chart.

Leak tracing chart - Auto leak test failed

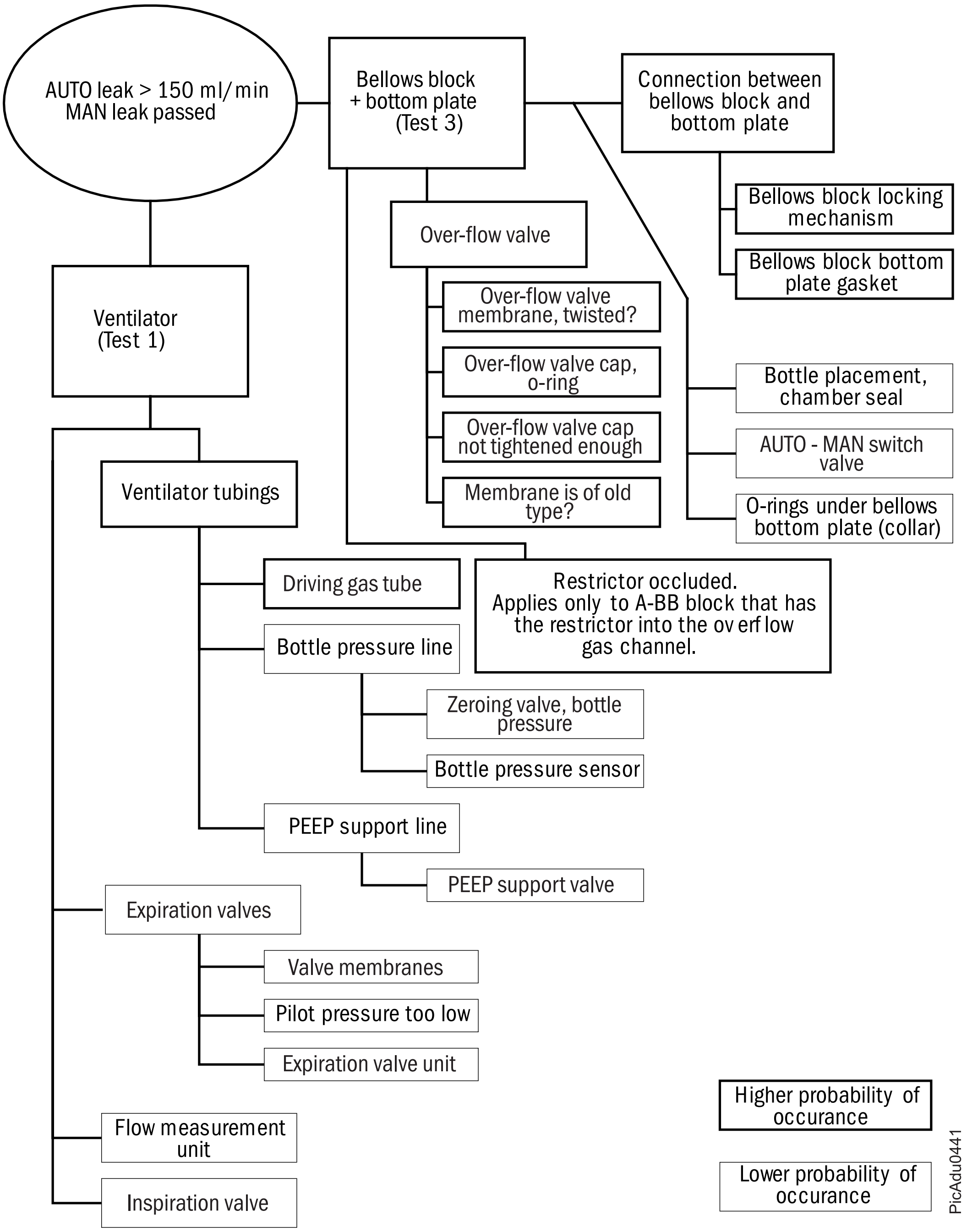
AUTO leak > 150 ml/min
MAN leak passed
Bellows block
+ bottom plate
(Test 3)
Connection between bellows block and bottom plate
Bellows block locking mechanism
Bellows block bottom plate gasket
Over-flow valve
Over-flow valve membrane, twisted?
Over-flow valve cap, o-ring
Over-flow valve cap not tightened enough
Membrane is of old type?
Bottle placement, chamber seal
AUTO - MAN switch valve
O-rings under bellows bottom plate (collar)
Ventilator
(Test 1)
Ventilator tubings
Driving gas tube
Restrictor occluded.
Applies only to A-BB block that has the restrictor into the overflow gas channel.
Bottle pressure line
Zeroing valve, bottle pressure
Bottle pressure sensor
PEEP support line
PEEP support valve
Expiration valves
Valve membranes
Pilot pressure too low
Expiration valve unit
Flow measurement unit
Inspiration valve
Higher probability of occurance
Lower probability of occurance
PicAdu0441

Figure 43 Leak tracing chart - Auto leak test failed

Leak tracing chart - Manual leak test failed

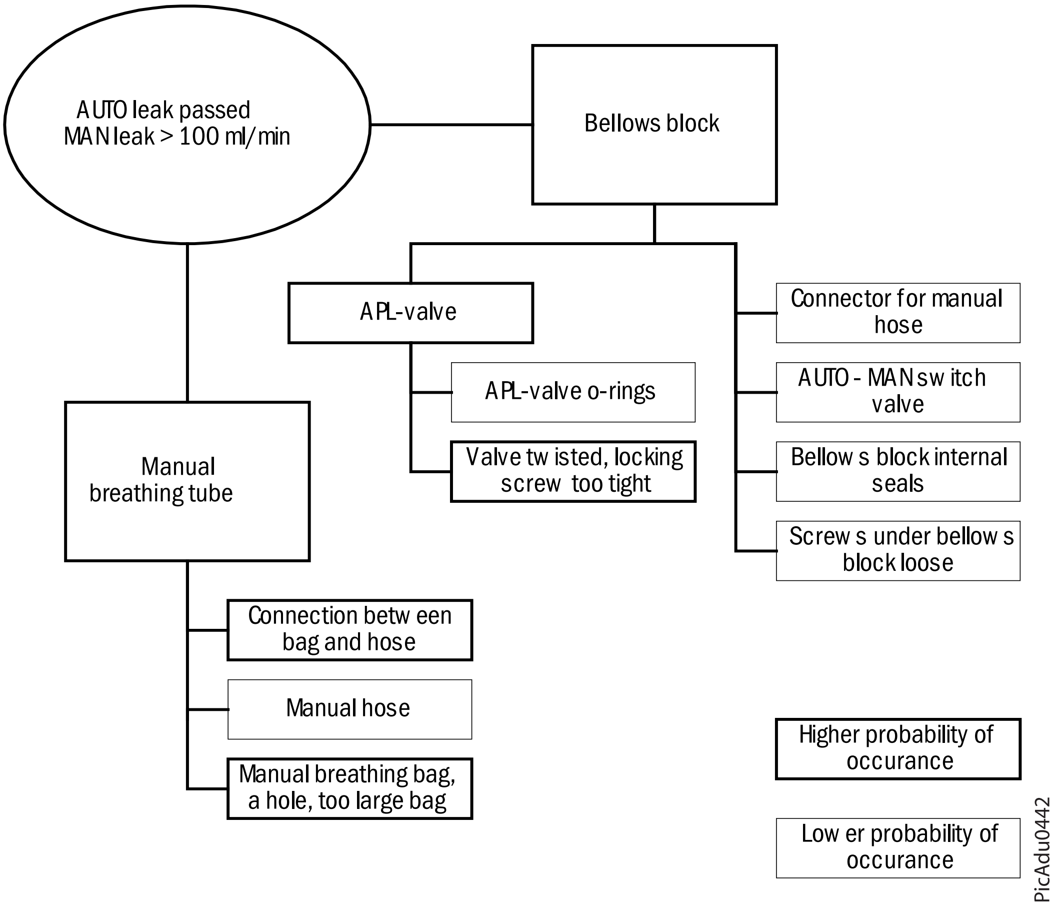
AUTO leak passed
MAN leak > 100 ml/min
Bellows block
APL-valve
APL-valve o-rings
Valve twisted, locking screw too tight
Connector for manual hose
AUTO - MAN switch valve
Bellows block internal seals
Screws under bellows block loose
Manual breathing tube
Connection between bag and hose
Manual hose
Manual breathing bag, a hole, too large bag
Higher probability of occurance
Lower probability of occurance
PicAdu0442

Figure 44 **Leak tracing chart - Manual leak test failed**

Leak tracing chart - Both auto and manual tests failed

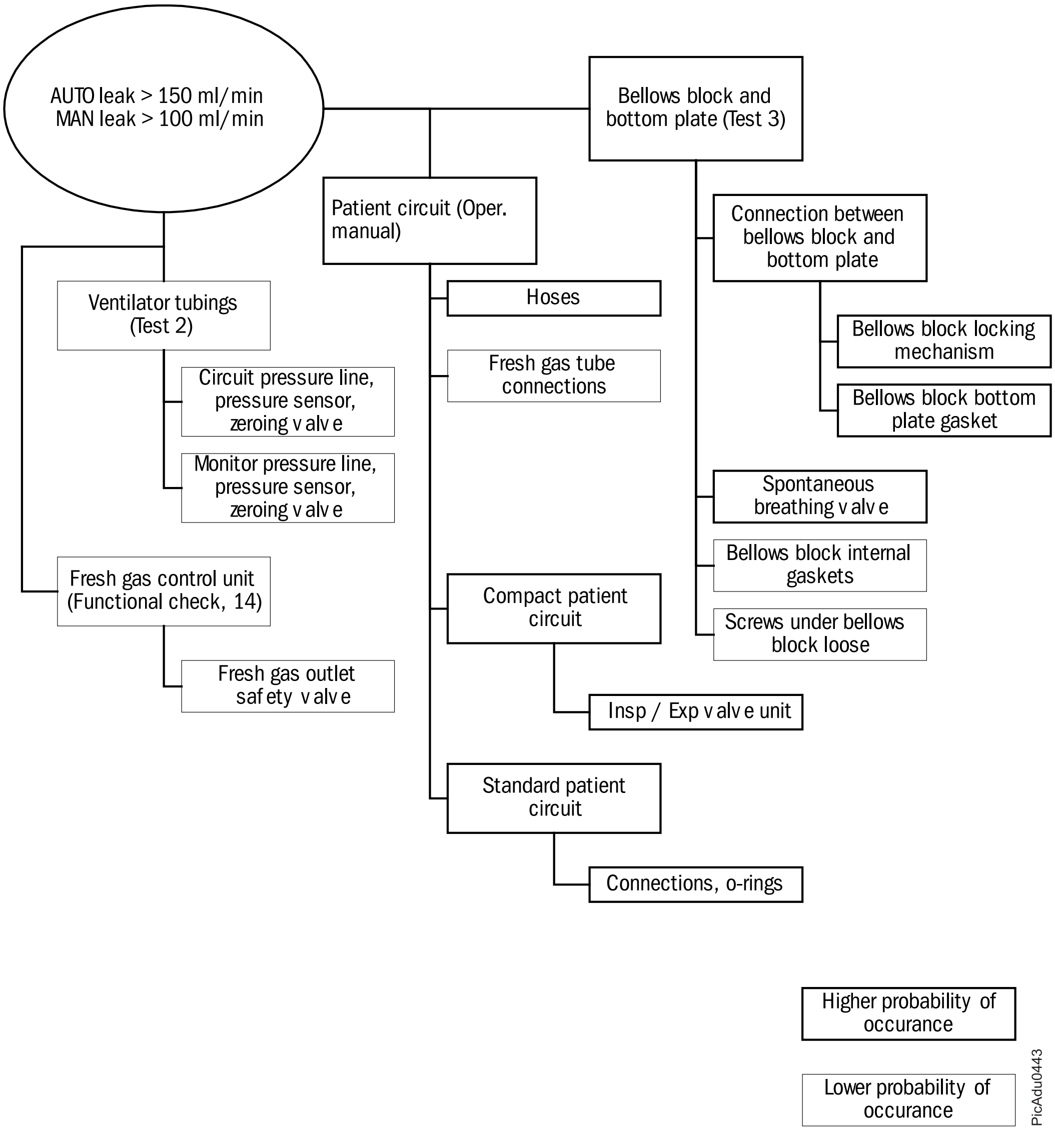
AUTO leak > 150 ml/min
MAN leak > 100 ml/min
Bellows block and bottom plate (Test 3)
Patient circuit (Oper. manual)
Connection between bellows block and bottom plate
Ventilator tubings (Test 2)
Hoses
Bellows block locking mechanism
Fresh gas tube connections
Circuit pressure line, pressure sensor, zeroing valve
Bellows block bottom plate gasket
Monitor pressure line, pressure sensor, zeroing valve
Spontaneous breathing valve
Bellows block internal gaskets
Fresh gas control unit (Functional check, 14)
Compact patient circuit
Screws under bellows block loose
Fresh gas outlet safety valve
Insp / Exp valve unit
Standard patient circuit
Connections, o-rings
Higher probability of occurance
Lower probability of occurance
PicAdu0443

Figure 45 Leak tracing chart - Both auto and manual tests failed

Leak tests for service purposes

These tests are for detecting leaks in specific areas of the ventilator and the bellows block. The test in "Ventilator test (Test 1)" on page C-80, includes expiration and inspiration valves, flow measurement unit, drive gas cylinder, bottle pressure line from the bellows block bottom plate to the chamber pressure sensor and zeroing valve as well as PEEP support line and peep support valve in the same way.

The test in "Test for circuit and monitor pressure sensor lines (Test 2)" on page C-80, involves the pressure lines to the circuit and the monitor pressure sensors and their zeroing valves.

The purpose of the test in "Test for Bellows block and bottom plate leakage (Test 3)" on page C-81, is to identify leakages in the bellows block and the bottom plate of the ADU for service purposes. The following procedure is for testing the possible points of leakage in Auto ventilation mode.

Ventilator test (Test 1)

1. The ADU in power On
2. The gas inlets connected to the central outlets
3. Enter Pneumatics Control on the Ventilator diagnostic page and Operate the expiration valves (EXP. and PEEP on the diagnostic page). Close them both.
4. Remove the bellows block.
5. Connect a pressure manometer (cuff pump) to the driving gas hole in the bellows block bottom plate with a suitable connector. See the figure below.
6. Pressurize the volume with the cuff manometer up to 30 mmHg.

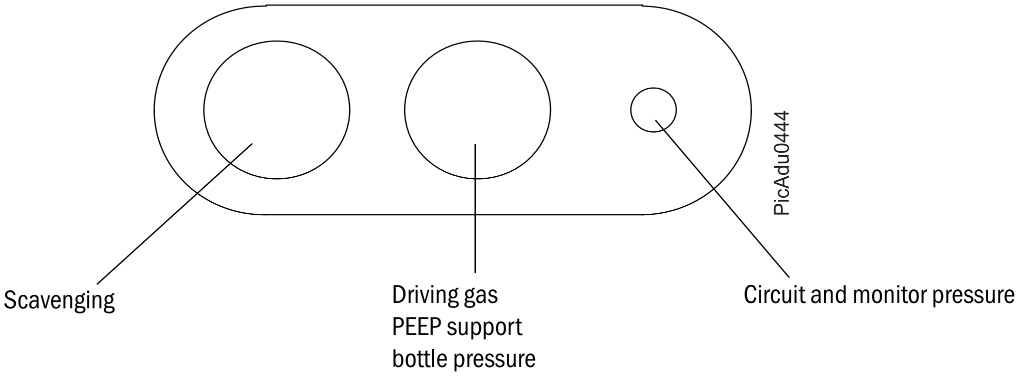

Figure 46 The channels in the Bellows Block bottom plate

7. Wait for a minute. A pressure drop of 2 mmHg in 10 seconds at 30 mmHg pressure corresponds approximately 10 ml/min. leakage. Pressure can also be observed from the output of bottle pressure sensor on the diagnostics page of the ventilator.

Test for circuit and monitor pressure sensor lines (Test 2)

1. Remove the bottom plate gasket.
2. Connect the cuff manometer to the circuit and to the monitor pressure hole of the bellows bottom plate. See the figure above.
3. Pressurize the circuit lines to 30 mmHg.

NOTE: Do not apply too high pressure to the lines as it may damage the pressure sensors.

4. A possible leakage can be detected by the pressure drop on the manometer or by the circuit and monitor sensor values on the ventilator service menu.

Test for Bellows Block and bottom plate leakage (Test 3)

1. Switch off the power and disconnect all gases.
2. Remove the bellows from the bottom plate.
3. Remove the upper left side panel.
4. Disconnect the drive gas tube from the bellows block bottom plate connection.
5. Connect one end of a circuit hose to the bellows block bottom plate drive gas tube connection (the place from where the ventilator drive gas tube was removed).
6. Disconnect tube 511 at the A-EV1 multi-connector and connect a cuff pump with manometer to the tube.

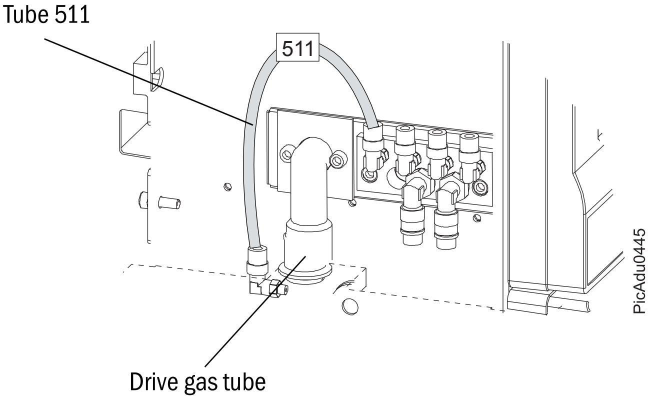

Figure 47 The location of drive gas tube and Tube 511

7. Relocate the bellows block with bellows chamber but without the bellows and then select Auto mode.
8. Connect the other end of the circuit hose to the bellows block patient circuit connector, thus forming a closed loop. See the figure below.
9. Pressurize the bellows block to 30 mmHg with the cuff pump. Wait one minute for stable conditions. When the pressure drop is 2 mmHg in 10 seconds at 30 mmHg pressure, the amount of leakage is around 30 ml/min.

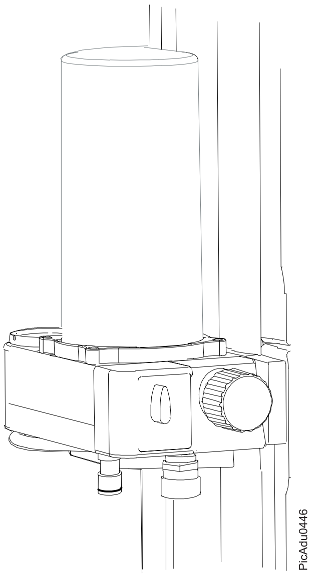

Figure 48 Setup for leakage check of Bellows Block and bottom plates

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SPARE PARTS A-EV1

General

Table YES (Y) = To replace the spare part the A-EV1 should be removed from frame.

Table NO (N)= Spare part can be installed without removing the A-EV1 from frame.

XX = Depending where installed.

*) Parts compatible with the AS/3 ADU S/N: 293001-294000, 981001-981110

Parts complete A-EV1 module

Item	Item description	Order No.	Y	N
	Ventilator module Exchange	A-EV1-E	X	
	Ventilator module New	A-EV1-S	X	

Parts for connecting the A-EV1 to the frame

Item	Item description	Order No.	Y	N
1	Seal	891713		X
2	Seal EV1 multiconnector	893161		X
3	Drive gas tube	891714		X
4	EV1 multiconnector	893401		X

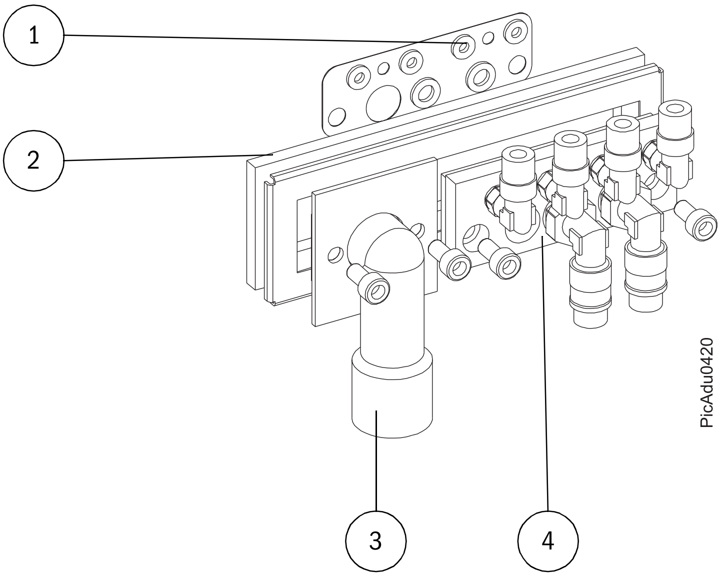

Figure 49 **The A-EV1 pneumatic multi-connector**

Parts behind the electronic cover

Item	Item description	Order No.	Y	N
1	DC/DC power board	896323*		X
2	Fuses F2 630 mA DC/DC board	511142*		X
3	Fuses F1 2.5A DC/DC board	511384*		X
4	CPU board	889466		X
5	EEPROM memory	13972*		X
6	A-EV1 software version (contact Datex-Ohmeda for latest version available)	XXXXXXX		X
7	Electronic cover	893808		X

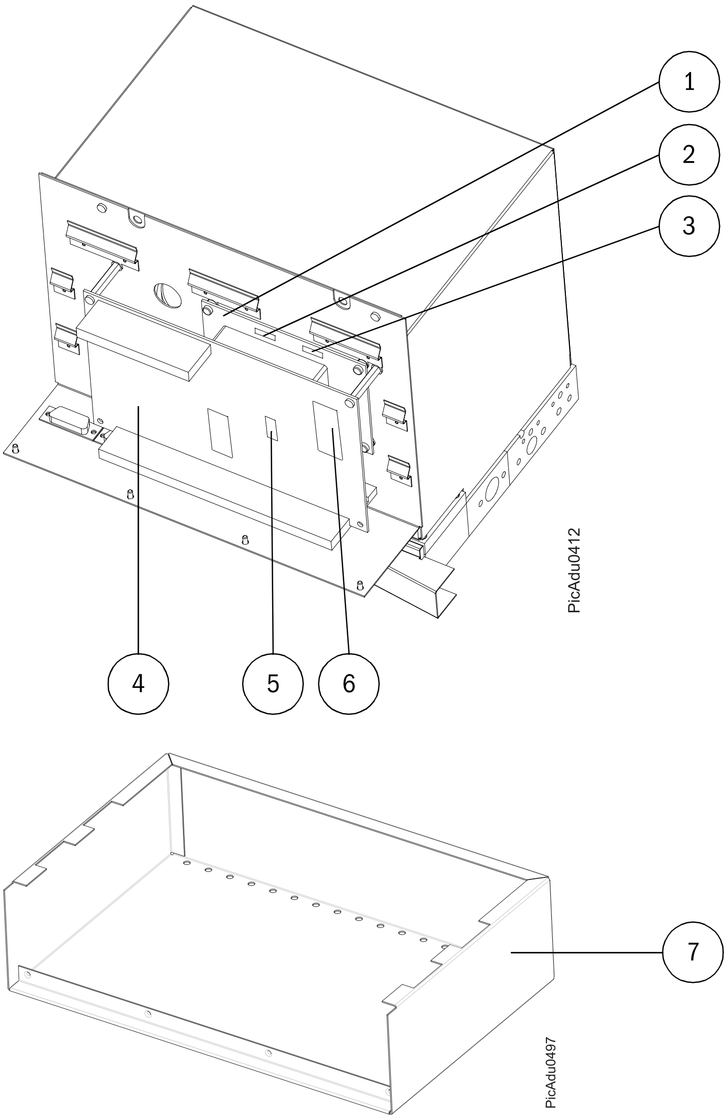

Figure 50 **The Electronic Ventilator control unit (A-EV1)**

Cable

Item	Item description	Order No.	Y	N
X	Cable between electronics and unit including seal grommet	889611		X

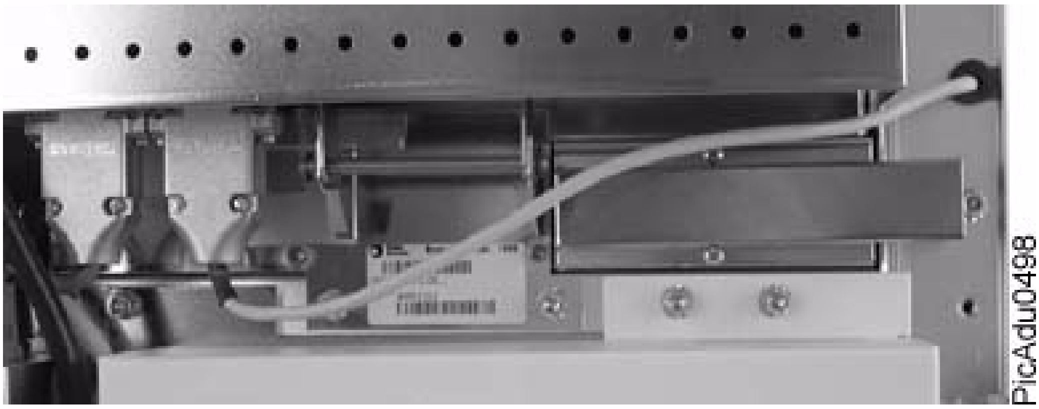

Figure 51 **Cable**

Parts inside the Electronic Ventilator (delivered after September 1998)

NOTE: To order sealing tape around chassis, see miscellaneous spares.

Item	Item description	Order No.	Y	N
1	Expiration pilot valve	890759		X
2	PEEP pilot valve	890758		X
3	PEEP proportional	890960		X

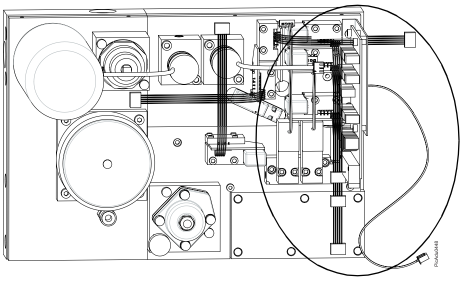

Figure 52 A-EV1 delivered after September 1998

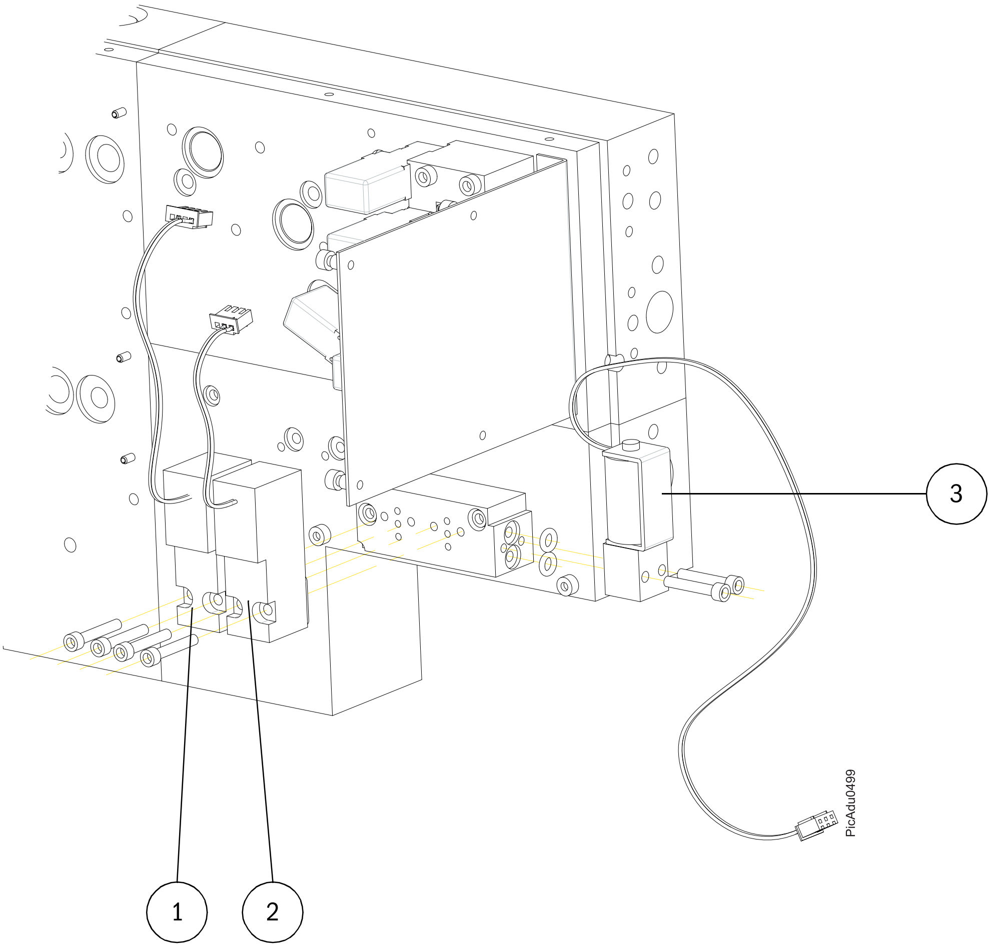

Figure 53

Item	**Item description**	**Order No.**	**Y**	**N**
1	Air pressure sensor	890404	X	
2	Oxygen pressure sensor	890404	X	
3	Flow sensor circuit board including Zeroing valve	8500952		X
4	Expiration valve unit	889616		X

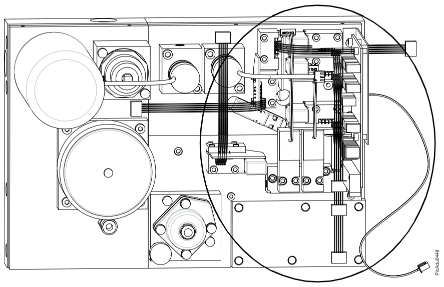

Figure 54 **A-EV1 delivered after September 1998**

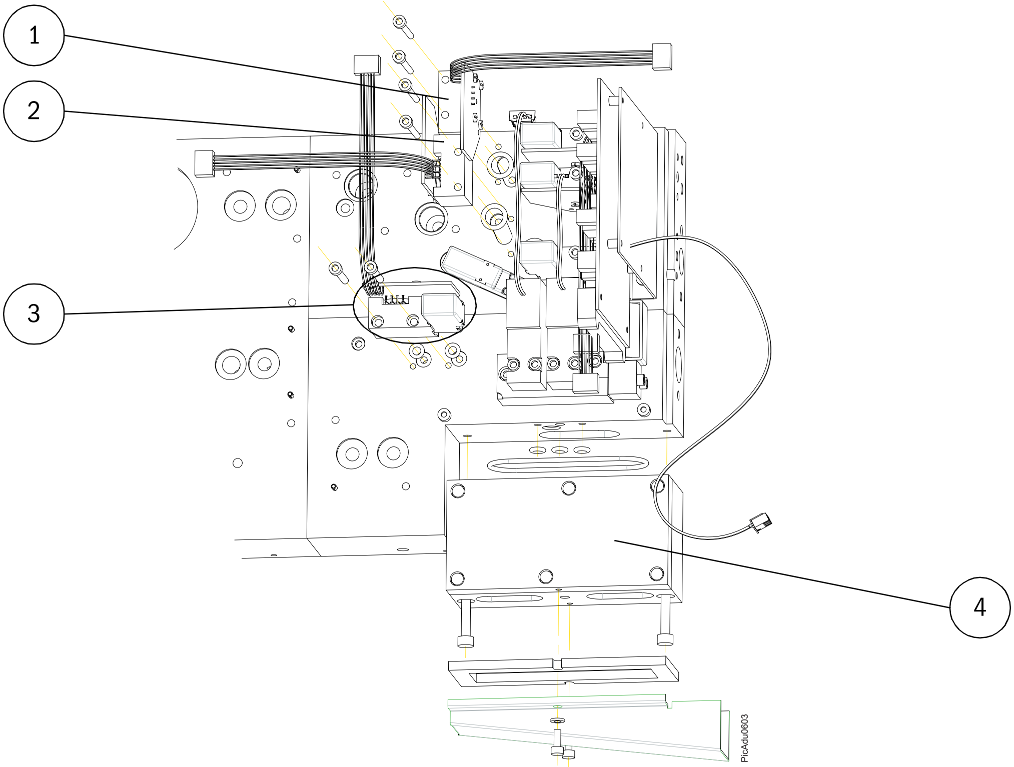

Figure 55

Item	Item description	Order No.	Y	N
1	Connection board	889615	X	
2	MUX valve	889521	X	
3	Pressure sensor board with Zeroing valve (Bottle pressure)	891382	X	
4	Pressure sensor board with Zeroing valve (Monitor pressure), Zero 1	889520	X	
5	Pressure sensor board with Zeroing valve (Circuit pressure), Zero 2	889520	X	

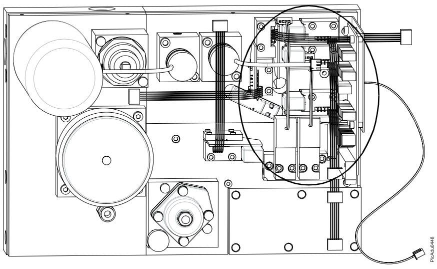

Figure 56 A-EV1 delivered after September 1998

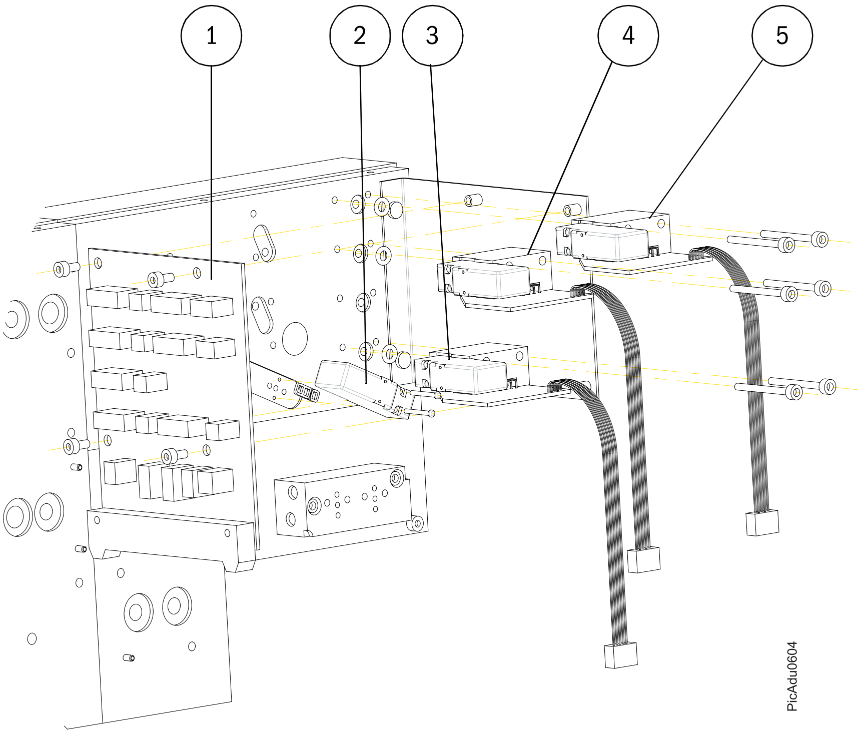

Figure 57

Item	Item description	Order No.	Y	N
1	Oxygen valve	610652700	X	
2	Air valve	610652800	X	
3	Pilot pressure regulator	8500169		X
4	One-way valve(s) placed underneath each Air and Oxygen valve	889679	X	

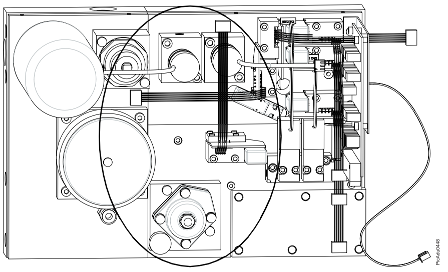

Figure 58 **A-EV1 delivered after September 1998**

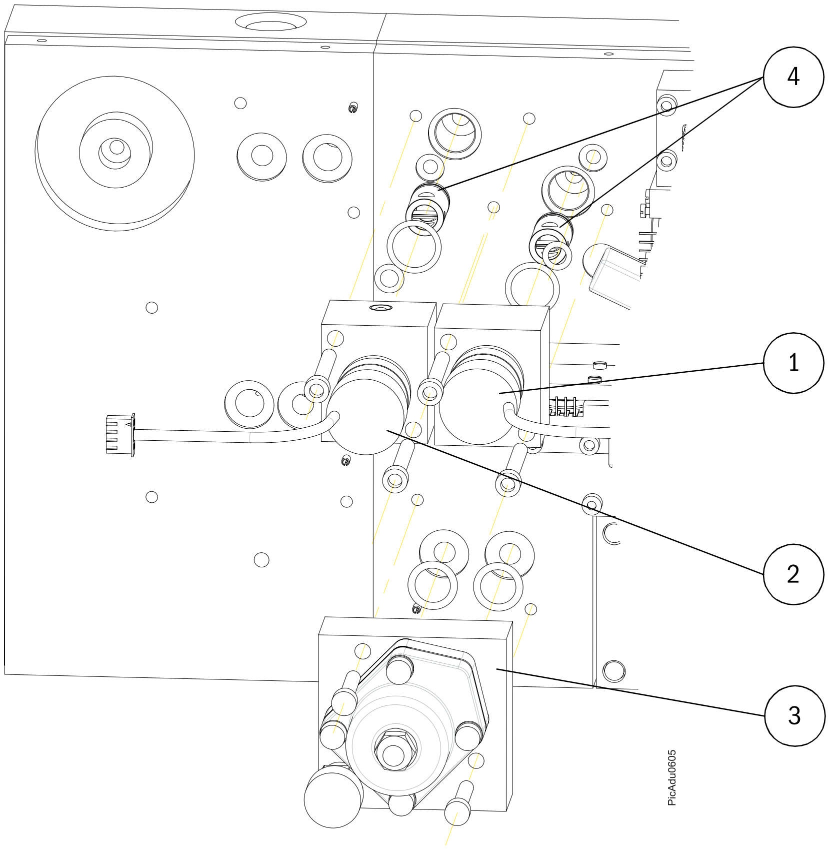

Figure 59

Item	Item description	Order No.	Y	N
1	Pressure reservoir	572561	X	
2	Inspiration proportional valve	8501705		X
3	Inlet pressure regulator	889734	X	
4	Pneumatic test connector for inlet pressure	646586	X	

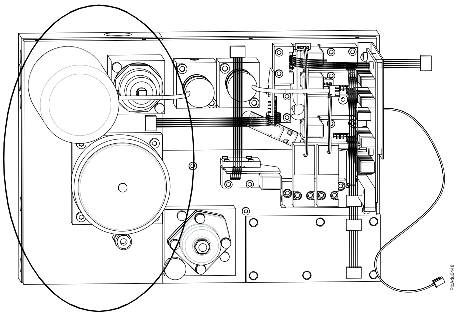

Figure 60 **A-EV1 delivered after September 1998**

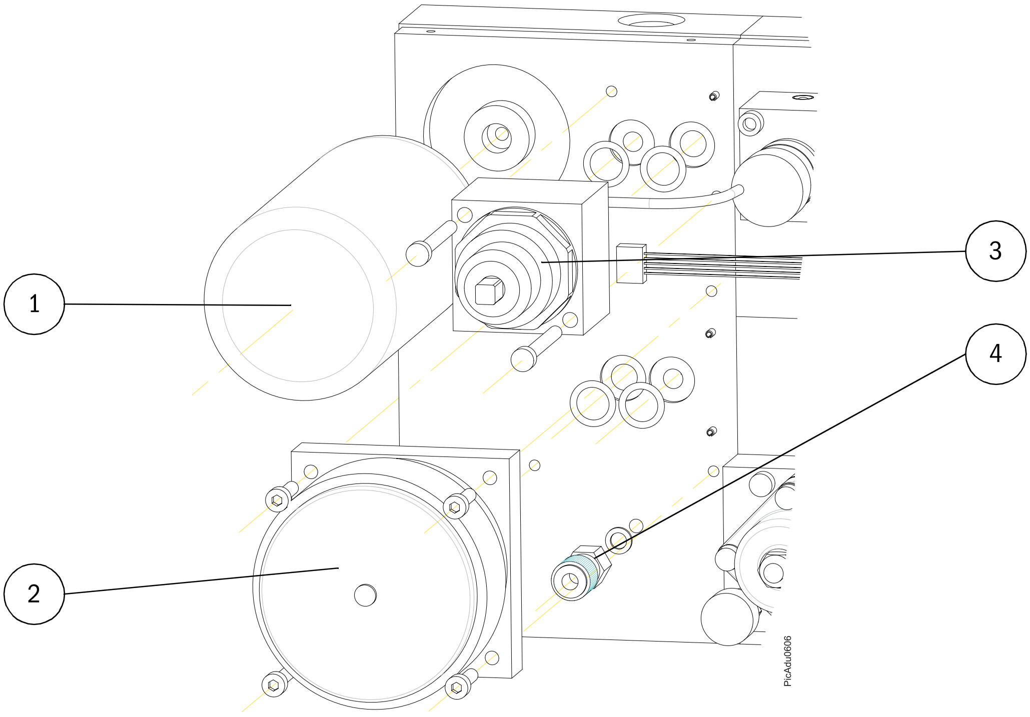

Figure 61

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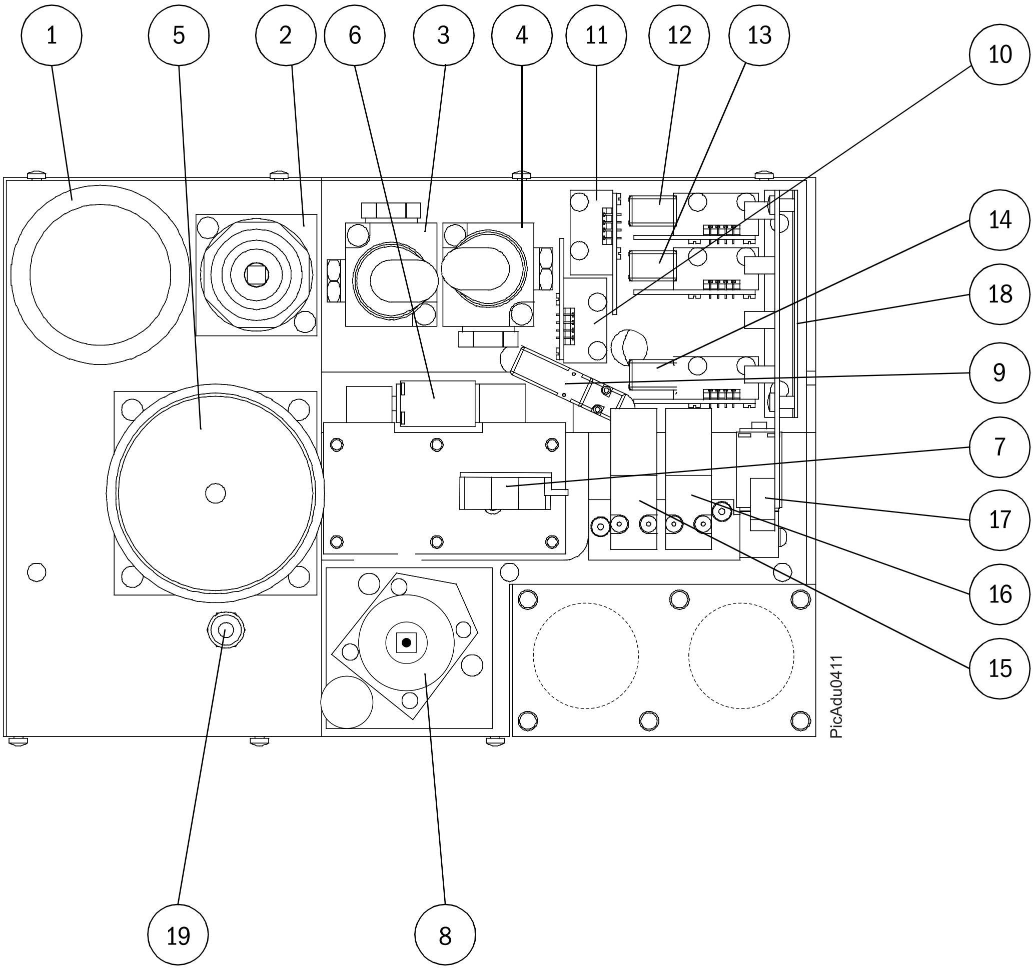
Parts inside the Electronic Ventilator (delivered before September 1998)

NOTE: To order sealing tape around chassis, see miscellaneous spares.

Item	Item description	Order No.	Y	N
1	Pressure reservoir	572561	X	
2	Inlet pressure regulator	889734	X	
3	Air valve	610652800	X	
4	Oxygen valve	610652700	X	
5	Inspiration proportional valve	8501705		X
6	Flow sensor-zeroing valve for A-EV1 manufactured before September 1998. The Zeroing valve is not mounted to the flow sensor board.	890978	X	
7	Flow sensor circuit board for A-EV1 manufactured before September 1998.	884227*		X
8	Pilot pressure regulator	8500169		X
9	MUX valve	889521	X	
10	Oxygen pressure sensor board	890404	X	
11	Air pressure sensor board	890404	X	
12	Pressure sensor board with zeroing valve (Circuit pressure), Zero 2	889520	X	
13	Pressure sensor board with Zeroing valve (Monitor pressure), Zero 1	889520	X	
14	Pressure sensor board with Zeroing valve (Bottle pressure)	891382	X	
15	Expiration pilot valve	890759		X
16	PEEP Pilot valve	890758		X
17	PEEP proportional	890960		X
18	Connection board	889615	X	
19	Pneumatic test connector for inlet pressure	646586	X	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PicAdu0411

Figure 62 A-EV1 delivered before September 1998

Expiration valve unit

Item	Item description	Order No.	Y	N
1	O-ring	65363		X
2	PEEP valve membrane	886432*		X
2	EXP. valve membrane	886432*		X
3	O-ring	050083349		X
4	Gasket for exhaust cover	891071		X
5	Exhaust cover	893649		X

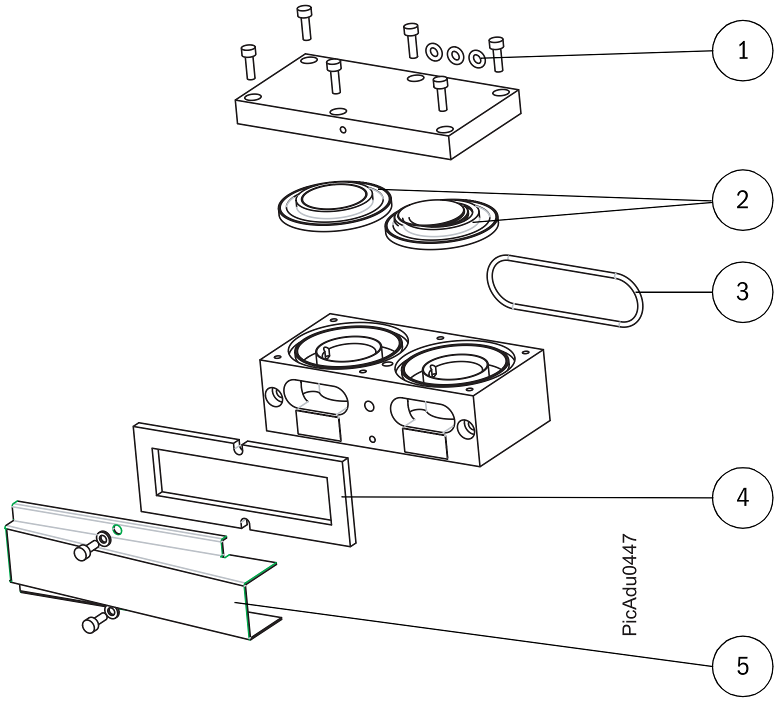

Figure 63 **Expiration valve unit**

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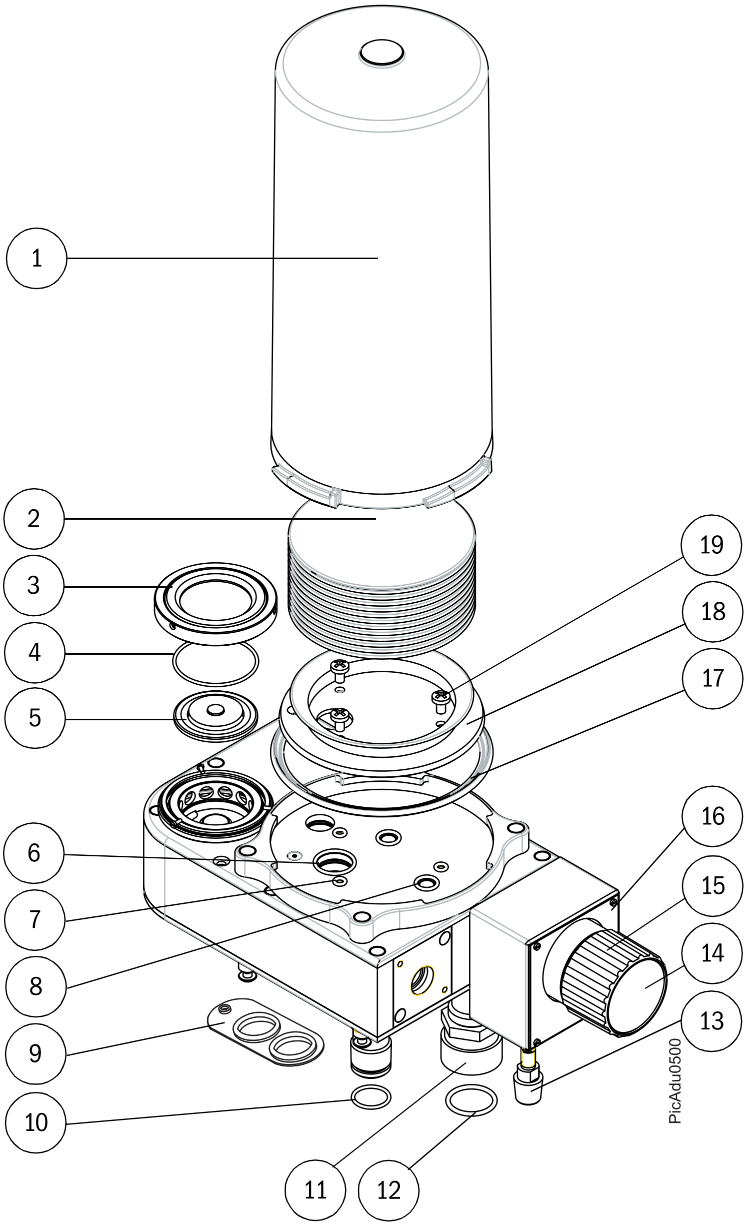
Bellows Block and APL valve

Item	Item description	Order No.
-	Complete exchange Bellows Block including APL valve	A-BB*
1	Bellows Chamber	886876*
2	Bellows	887747
3	Overflow valve cap	889422*
4	Overflow valve O-ring	656498*
5	Overflow valve membrane	889112*
6	O-ring, 20 x 2, EPDM Bottom plate	65389*
7	O-ring, 4 x 2, VITON, SHORE 70 (Bottom plate), 3 pcs required	65394*
8	O-ring, 10 x 2, EPDM (Bottom plate), 2 pcs required	656499*
9	Bellows bottom plate gasket (Mounted on A-AUF)	886394*
10	O-ring, Patient circuit connector	65374
11	O-ring, manual bag connector	656507*
12	Manual bag connector	64083
13	Conical occluder	884425*
14	APL valve sticker	893329*
15	APL valve (Exchange)	889114*
16	APL valve scaled label	887635*
17	Bellows chamber gasket	886412*
18	Bellows bottom plate	886404*
19	Screw, (Pozidriv) for bellows plate, 3 pcs required	61770*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PicAdu0500

Figure 64 **Bellows Block A-BB and APL valve**

Item	**Item description**	**Order No.**
1	Screw for plate under bellows block	619392
2	Seal, bellows block lower plate.	886418*
3	Seal, between bellows block and upper plate.	886413*
2, 3, 4, 5	Restrictor kit (includes 5 of each item).	8501389

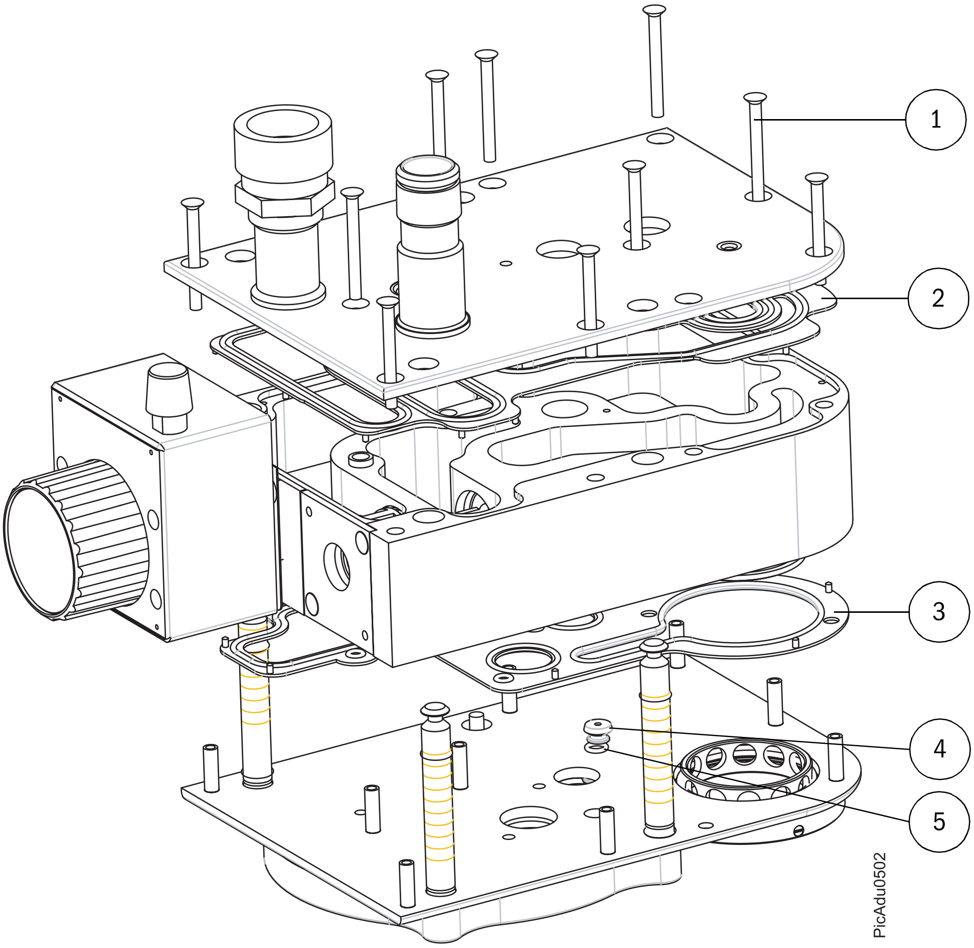


Figure 65 **Exploded view of Bellows Block (upside down)**

Bellows Block spontaneous valve

Item	Item description	Order No.
1	Spontaneous valve A-BB	894613*

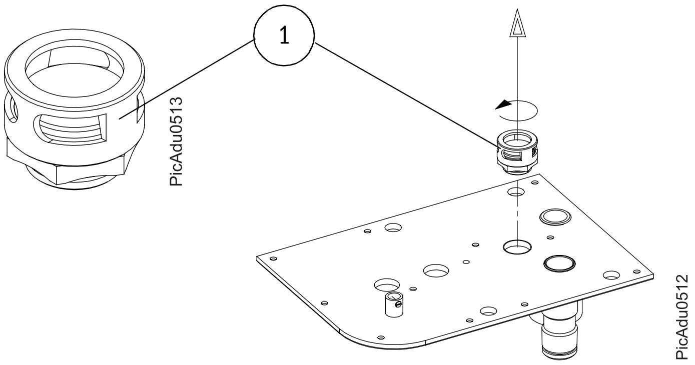


Figure 66 **Spontaneous valve**

Bellows Block bottom plate

Item	Item description	Order No.
-	Bellows block bottom plate	891912*
1	O-Ring 17,1x1,6 FPM70 (Between bottom plate and frame)	65364
2	O-ring, 10 x 2, EPDM (Between bottom plate and frame)	656499

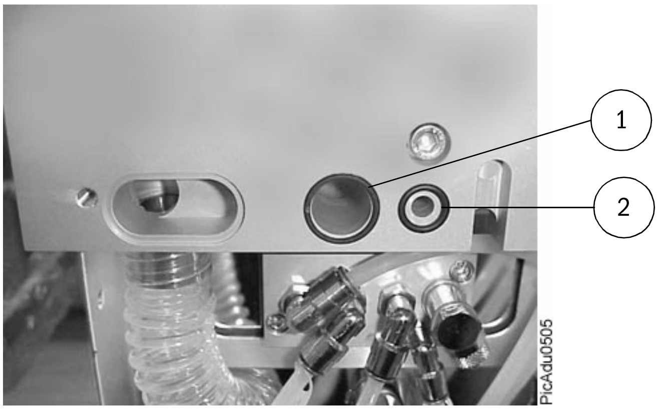


Figure 67 **Bellows Block bottom plate O-rings**

Item	Item description	Order No.
-	Bellows block bottom plate; exchange unit	891912*
1	O-ring Bottom plate	65642*
2	O-ring Bottom plate	65364*
3	Screw Bottom plate	613240*
4	T-plate Bottom plate	894122*
5	Shaft guide Bottom plate	887118*
6	Auto/Man. knob	???
7	Screw Auto/Man. knob	???????

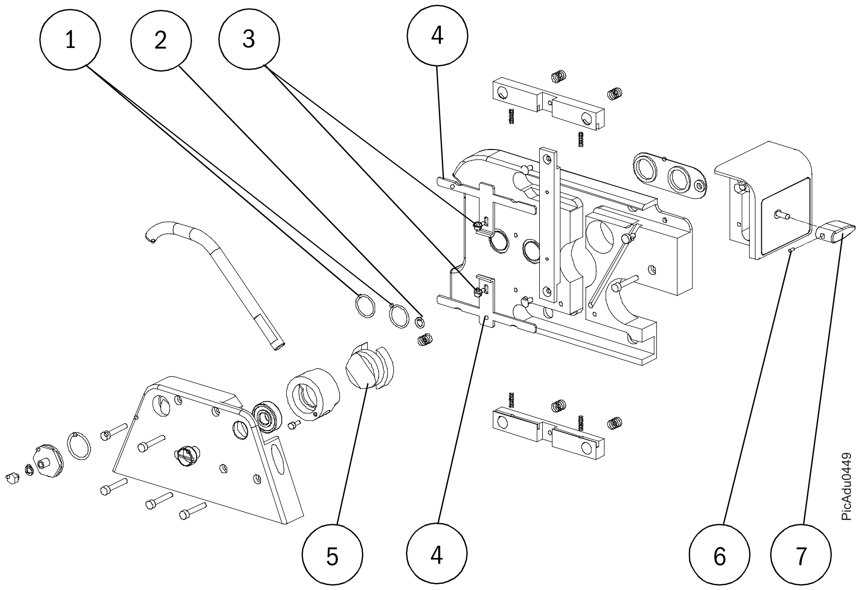


Figure 68 Exploded view of Bellows Block bottom plate

APL valve

Item	Item description	Order No.
1	Valve head (APL valve) Teflon	889117*
2*	APL valve O-ring (2 pcs)	656391*
3	Locking ring (APL valve)	8502636*
*	APL valve O-ring (1 pcs)	656505*

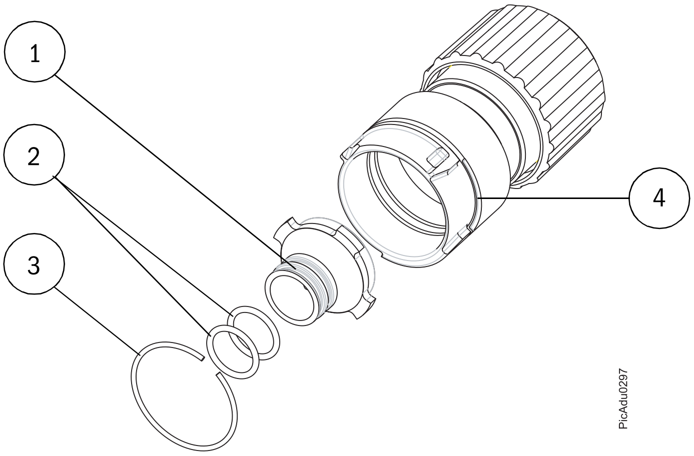


Figure 69 **APL Valve**

Gaskets for APL valve house

Item	Item description	Order No.
1	Gasket (APL house to block)	890505
2	Gasket (APL valve), bayonet button cover	890506*

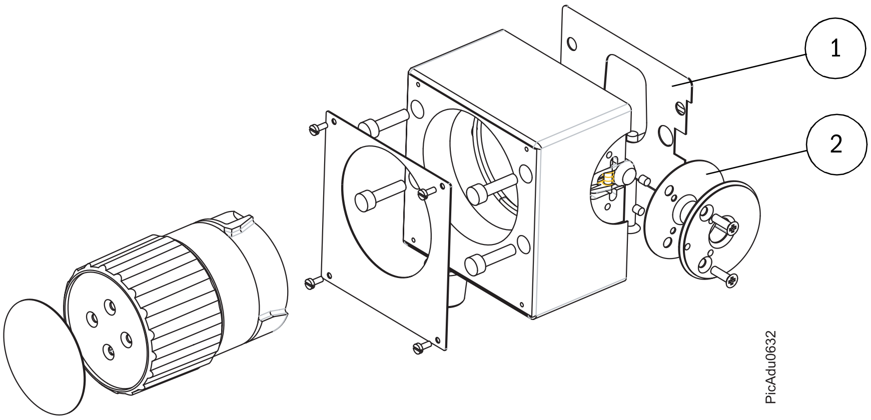


Figure 70 **APL valve and valve house**

Auto/Manual mode switch

Item	Item description	Order No.
-	Auto/Man. valve repair kit (including item 1-5)	8502830
1	O-ring, 20 x 2, EPDM (Bottom plate & Auto/Man valve)	
2	O-ring, 23 x 2, VITON, SHORE 70 (Auto/Man valve)	
3	seal	
4	O-ring, 26 x 2 VITON, SHORE 70 (Auto/Man. valve)	
5	Lip seal, (Auto/Man. valve)	
	Auto/Man. valve New	887095*

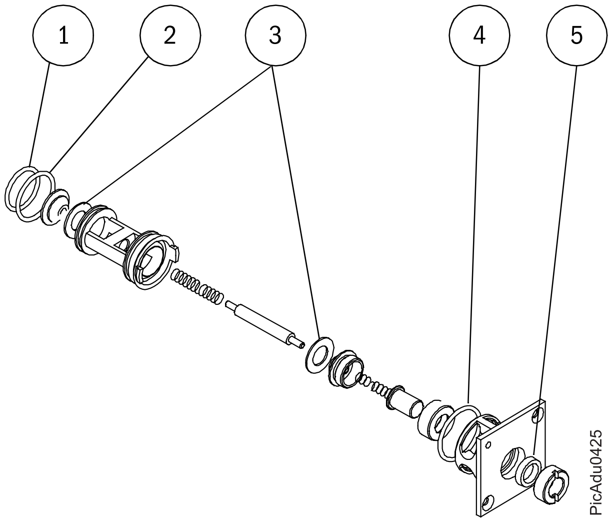


Figure 71 **Auto/Manual mode switch**

Auto/Manual mode switch mechanism

Item	Item description	Order No.
-	Repair kit Auto/Man. switch mechanism	8503473
1	Spring	
2	Switch cam	
3, 4	Switch spindle	
5	Teflon washer	
-	Tool for Auto/Man. switch key	735093

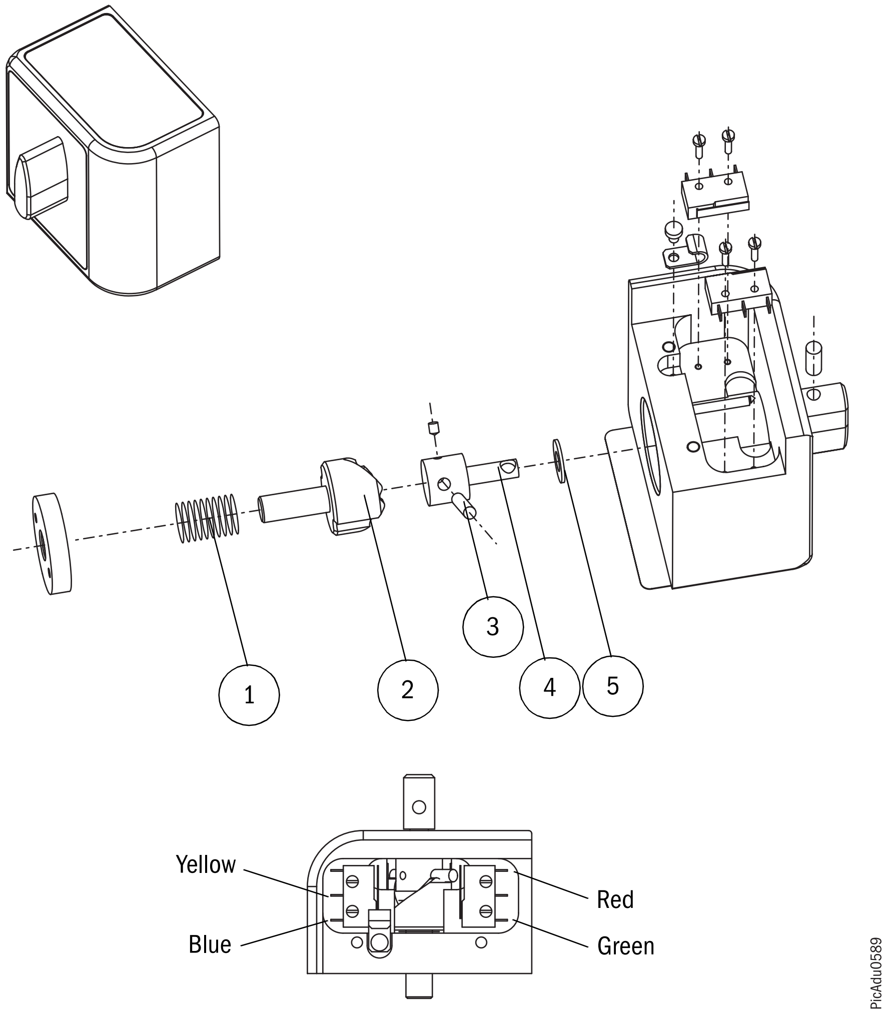

3
1
2
4
5
Yellow
Blue
Red
Green
PicAdu0589

Figure 72 **Auto/Manual mode switch mechanism**

Auto/Manual mode switch cable

Item	Item description	Order No.
-	Auto/Man. switch cable	884291

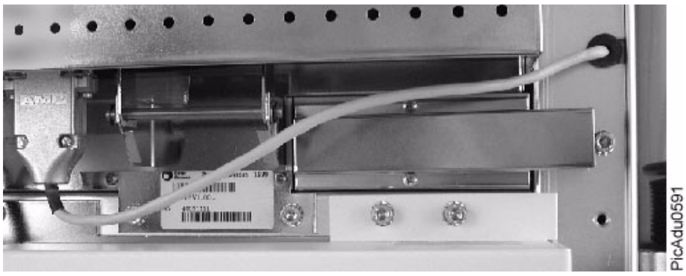


Figure 73 **Auto/Manual mode switch cable**

Miscellaneous

Item	Item description	Order No.
-	Sealing tape	8501943

Sealing tape

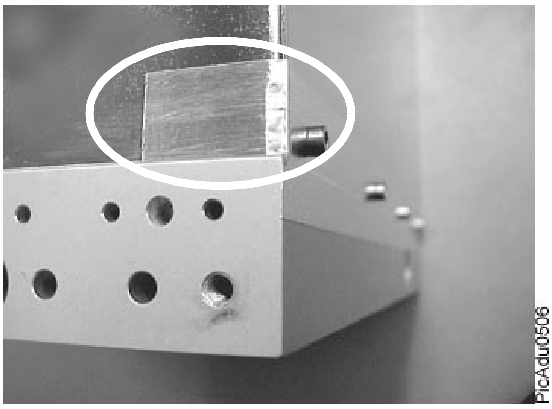


Figure 74 **Sealing tape**

TECHNICAL DESCRIPTION A-ELEC

General description

This section describes the Central Electronics (A-ELEC) of the ADU. The electronics of the Fresh Gas Control Unit (A-FGC1) and the Electronic Ventilator (A-EV1) are described separately.

The Central Electronics of the ADU consists of:

- Power supply
  The power supply transforms and rectifies mains AC voltage into lower DC voltage. The DC voltage is distributed to the consuming units via a power bus (VBUS). The VBUS has a battery backup for mains power loss. The A-FGC1 and the A-EV1 have their own DC/DC converters for generating proper voltages from the VBUS to the analogue or digital circuits.
- Digital section for data processing
  The digital section consists of:
  - CPU board
    The CPU board processes the information from the A-FGC1, A-EV1, keyboard and the Anesthesia Monitor (AM) or Capnomac Ultima (when connected).
  - VGA display controller board
    The board feeds the information from the CPU board to the flat display.
- Flat display with keyboard
  The flat display consists of a power supply and an 8-color LCD display with backlight. The keypad, with its own CPU board, is also located in the display unit.
- Audio amplifier board
  The audio amplifier board is located on the mother board. Its function is to amplify alarm signals to the loudspeaker from the CPU board.
- Auxiliary power outlets A-EO
  The auxiliary power outlets are equipped with fuses for each outlet.

CAUTION The auxiliary power outlets are only energized when the power cord of the ADU is connected, not when running on batteries.

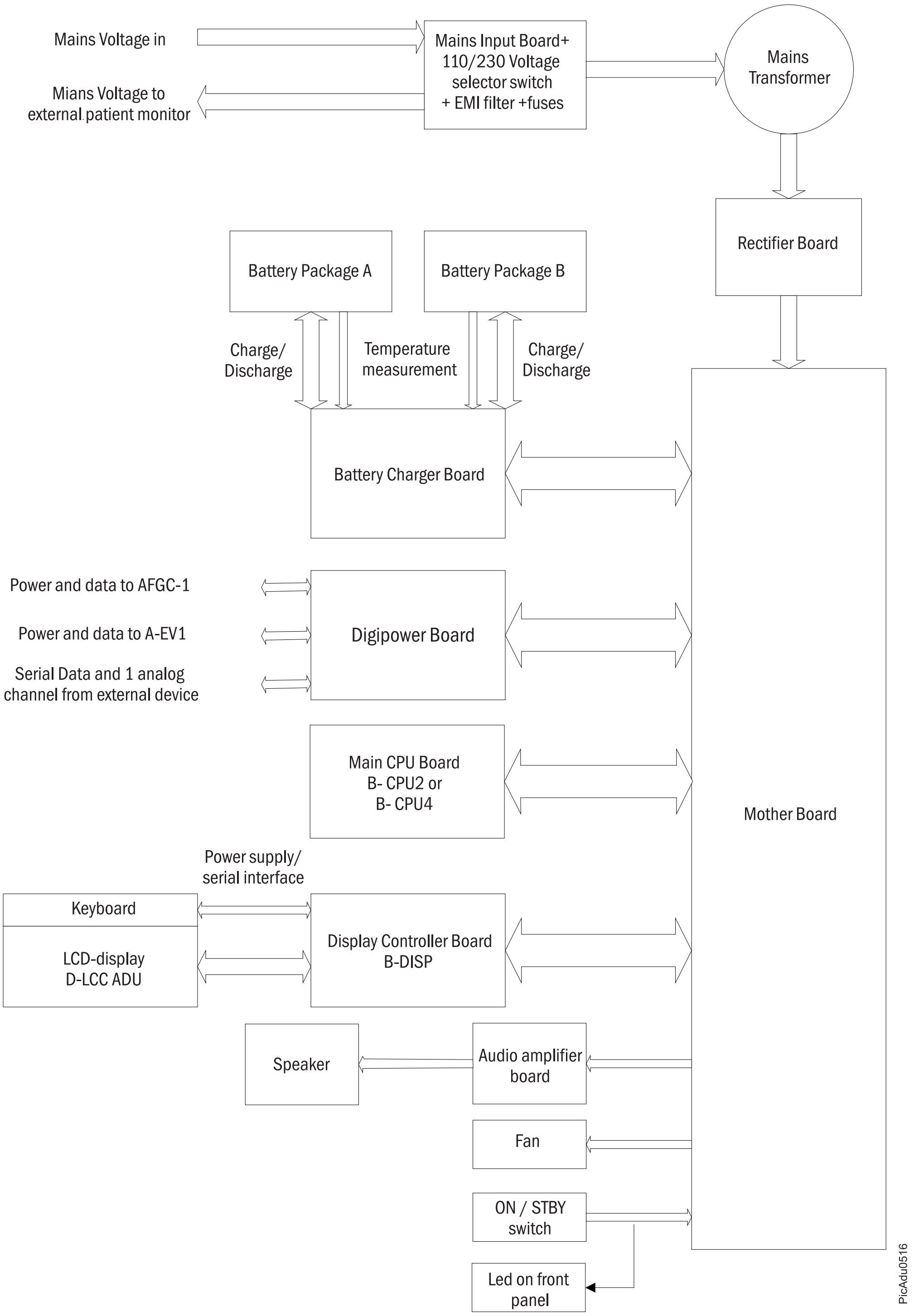

Mains Voltage in
Mians Voltage to external patient monitor
Mains Input Board+ 110/230 Voltage selector switch + EMI filter +fuses
Mains Transformer
Rectifier Board
Battery Package A
Battery Package B
Charge/ Discharge
Temperature measurement
Charge/ Discharge
Battery Charger Board
Power and data to AFGC-1
Power and data to A-EV1
Serial Data and 1 analog channel from external device
Digipower Board
Main CPU Board B- CPU2 or B- CPU4
Mother Board
Power supply/ serial interface
Keyboard
LCD-display D-LCC ADU
Display Controller Board B-DISP
Speaker
Audio amplifier board
Fan
ON / STBY switch
Led on front panel
PicAdu0516

Figure 1 Principle of the Central Electronics

Location of parts inside the Central Electronics

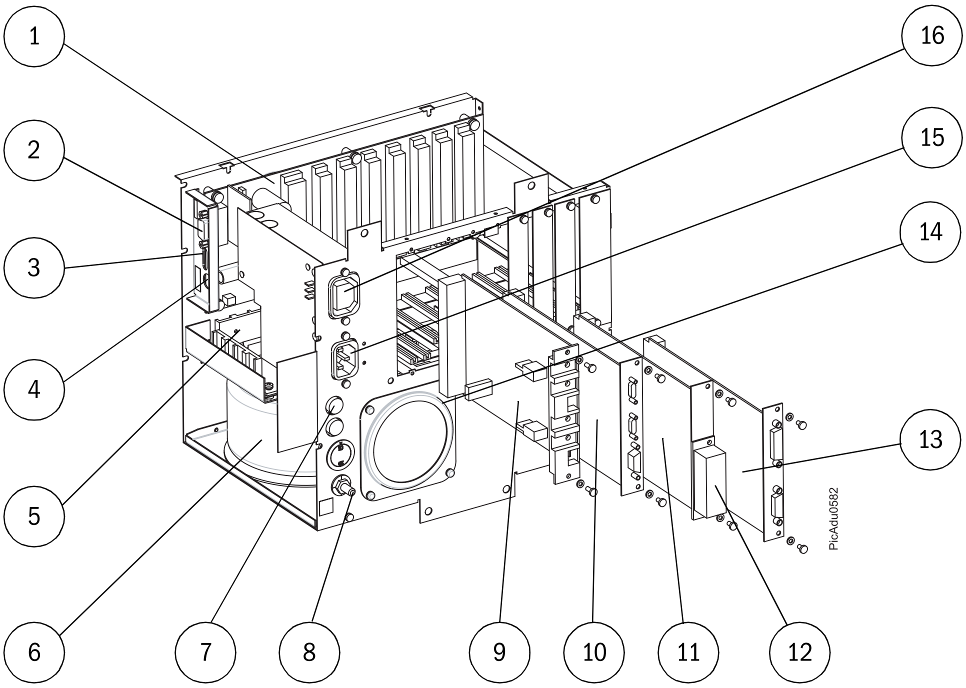


Figure 2 The parts of the Central Electronics

Item	Item description	Item	Item description
1	Mother board	9	Battery charger board
2	On/Standby Connector for cable	10	Digipower board
3	Indicator LEDs	11	B-CPU4 board
4	Fuse	12	Software cartridge
5	Rectifier board	13	Video Controller board (B-disp)
6	Transformer (110/230V)	14	Fan
7	Main Fuses	15	Mains inlet
8	Potential equalization terminal	16	Mains outlet for monitor system

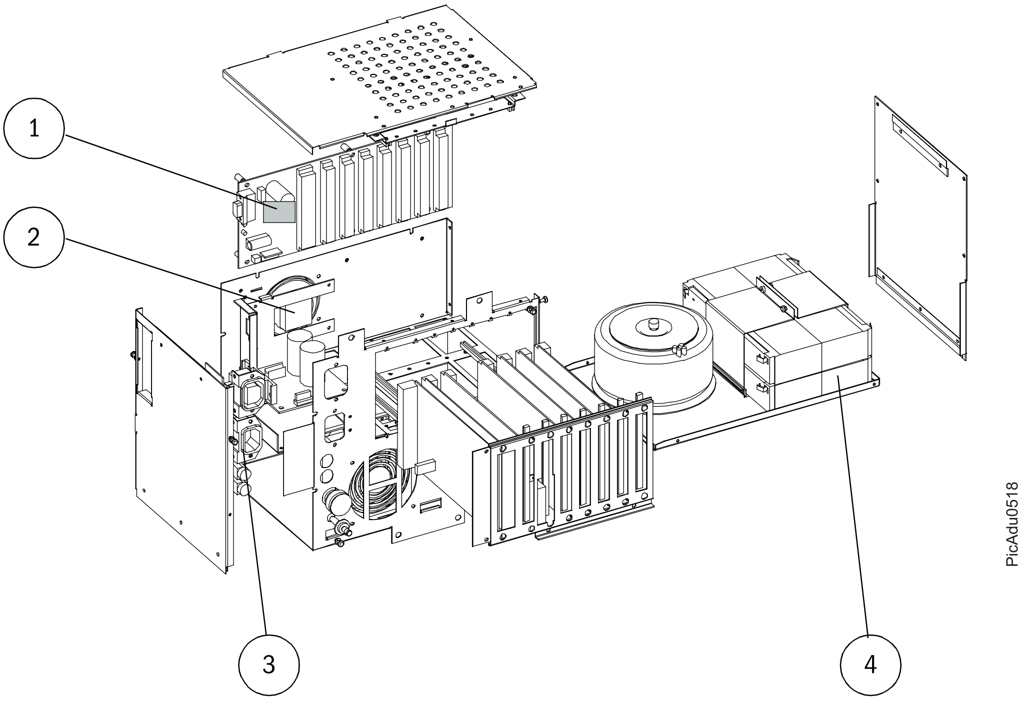


Figure 3 Exploded view of the Central Electronics

Item	Item description
1	Audio amplifier board
2	Loudspeaker
3	Mains Connection Board
4	Batteries

Functional description of the circuitboards

Mains Connection Board

The function of the mains connection board is to supply mains voltage to the mains transformer and to the external power outlet.

The mains voltage is connected to the board through the EMI filter. The same kind of filter is connected to the board's mains voltage external outlet. The fuses for the outlet are located inside the unit.

The voltage selector switch is connected to the filter output via the ADU's primary fuses. The selector connects the mains voltage to the proper primary winding of the mains transformer. The two options are 110V and 230V.

To protect the ADU from voltage spikes and to limit inrush current both VDRs (one for each voltage range) and a NTC resistor are utilized.

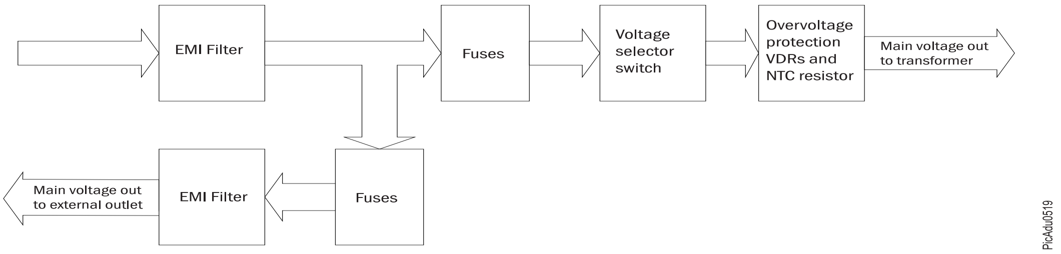

EMI Filter
Fuses
Voltage selector switch
Overvoltage protection VDRs and NTC resistor
Main voltage out to transformer
Main voltage out to external outlet
EMI Filter
Fuses
PicAdu0519

Figure 4 **Mains Connection Board**

Mother board

The mother board includes data, address, control and power buses which are needed for the communication between the main CPU board and the other boards.

The ADU is powered by VRAW voltage from the rectifier board. The mother board contains two FET switches which couple VRAW to the power bus (VBUS) when in mains use. Each one of these is dimensioned to supply the entire ADU. Indication LEDs for both switches light when the unit functions correctly. These FET switches are controlled by the On/Standby switch connected to the mother board.

The VBUS is connected to the A-FGC1 and A-EV1 modules through the digipower board, to the LCD display through the display controller board and to the audio amplifier board.

The battery charger board is powered by VRAW voltage, so that the batteries are charged also when the ADU is in standby mode.

On the mother board there is also a power supply for mains voltage LED and voltage limiter for fan. The voltage limiter is needed when VRAW is higher than 24V.

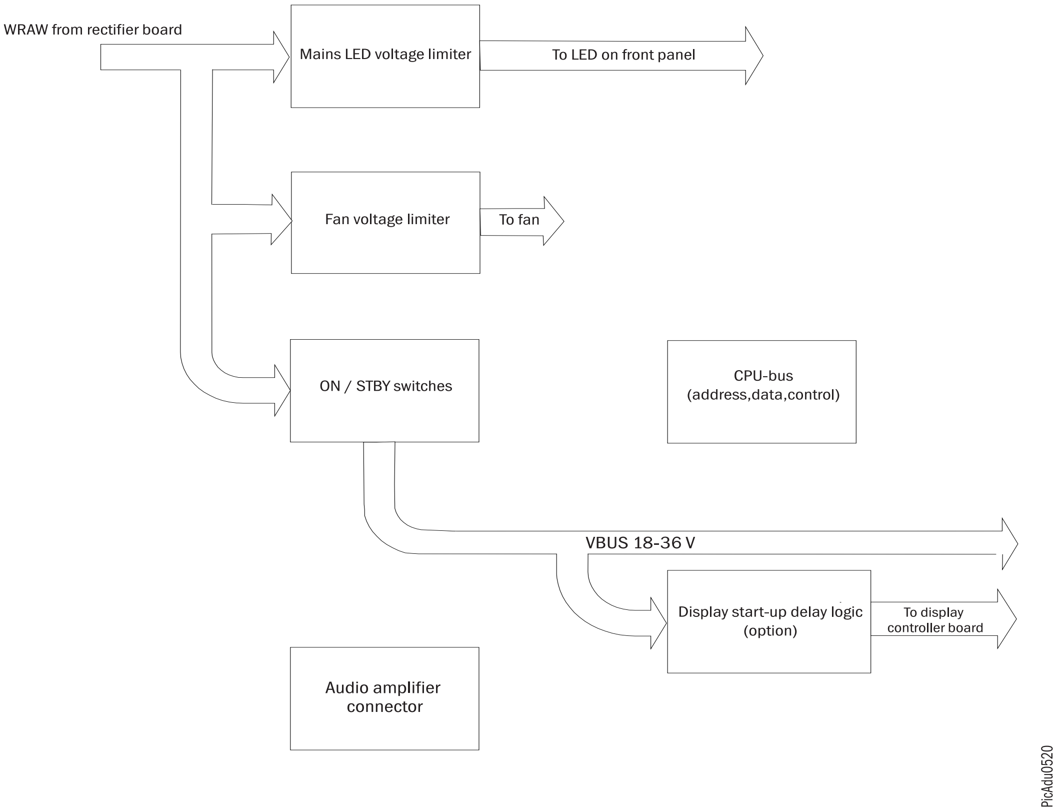

WRAW from rectifier board
Mains LED voltage limiter
To LED on front panel
Fan voltage limiter
To fan
ON / STBY switches
CPU-bus
(address,data,control)
VBUS 18-36 V
Display start-up delay logic
(option)
To display
controller board
Audio amplifier
connector
PicAdu0520

Figure 5 Mother board

Rectifier board

The function of the rectifier board is to rectify and filter the mains transformer output.

There are also comparators and switches that will turn off the output if the voltage is below 18 V or above 36 V. The function of this feature is to protect the electronics from overvoltage and undervoltage.

The output voltage of the board is VRAW and it powers the ADU when on mains power.

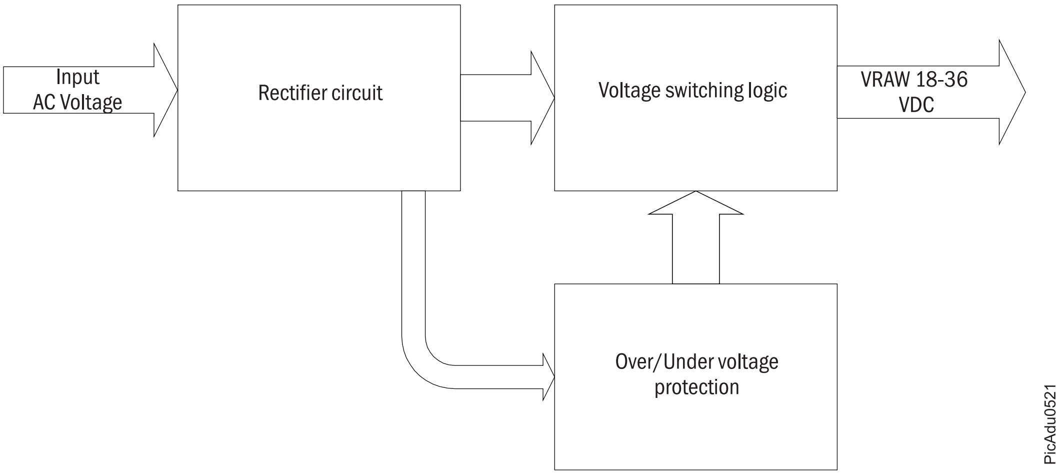


Figure 6 Rectifier board

Battery charger board

The function of the battery charger board is to charge the batteries when the ADU is connected to the mains and to supply power from the batteries to the VBUS if the mains is lost and the ADU is on.

There are two independent sets of batteries, (totally 4 batteries 12 V 2 Ah SLA-type) each having its own charger circuit. The charger is of the constant current type with the output voltage limited to a level suitable for standby use. As the charging voltage is temperature dependent, the temperatures of the batteries are measured.

The charger circuits also include test loads for the batteries, so that the condition of the batteries can be monitored. The CPU controls the test load, so that the battery voltage can be measured under load. The charger circuits are disabled when the test load is applied.

The line comparator measures VRAW voltage and controls the battery switches. If VRAW drops below 20 V the batteries are connected to the VBUS and the ADU becomes battery powered. A signal from the On/Standby switch is also controlling the function, so that the unit also can be switched on and off when on battery power.

The CPU can also read a signal from the line comparator. If the line signal goes inactive a ”Mains lost” alarm is generated.

A shutdown comparator measures the battery voltage. If it drops below 20 V a shutdown signal is sent thus causing a shutdown alarm: ‘Battery empty, go manual‘. This also triggers the shutdown timer which after a period of 30s, disconnects the batteries switches and the ADU is switched off.

The main CPU measures battery voltages, currents and temperature. There is an A/D-converter and a CPU bus interface logic for that purpose. These circuits are supplied from a separate +5V supply powered from the VBUS.

Signals from the battery voltage and current measurement, are amplified and scaled to the A/D-converter input range of 0 to 10V. Voltages from all four batteries, currents from both battery packs and temperature from battery pack A are measured. The eighth channel of the A/D-converter is reserved for an external analogue input.

The reference voltage for the A/D-converter is derived from +5V reference voltage. It is also used as a reference for the line comparator, shutdown comparator and battery charger circuit.

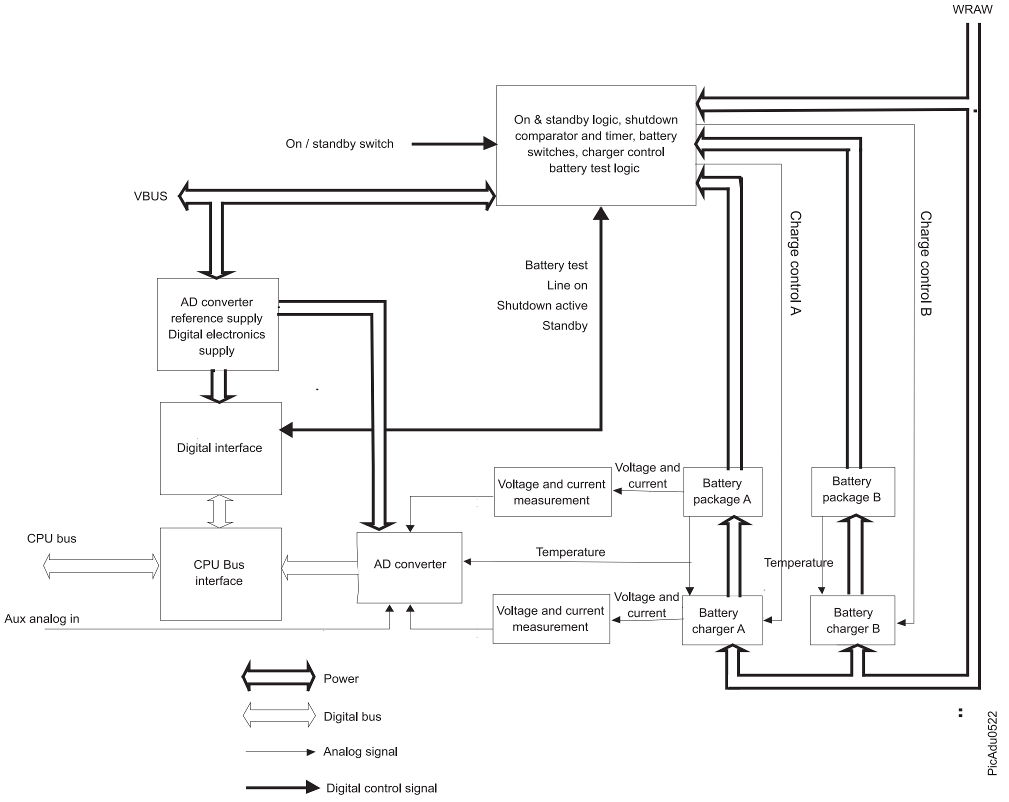

WRAW
On & standby logic, shutdown comparator and timer, battery switches, charger control battery test logic
On / standby switch
VBUS
Charge control A
Charge control B
Battery test
Line on
Shutdown active
Standby
AD converter reference supply Digital electronics supply
Digital interface
Voltage and current measurement
Voltage and current
Battery package A
Battery package B
CPU bus
CPU Bus interface
AD converter
Temperature
Temperature
Aux analog in
Voltage and current measurement
Voltage and current
Battery charger A
Battery charger B
Power
Digital bus
Analog signal
Digital control signal
PicAdu0522

Figure 7 **Battery charger board**

Mains / Battery switching logic

The batteries are disconnected if:

- Mains power is available and the ADU is switched on.
- The ADU is in standby mode.
- The ADU was running on battery has turned itself off after the batteries are discharged.

In all other cases the ADU gets its power from the batteries. The batteries are always put on charge when the mains power is available. The battery logic is based on four comparators and one timer circuit.

Audio amplifier board

The audio amplifier board is mounted on the mother board. Its function is to amplify alarms signals generated on the CPU board to the loudspeaker. It generates 1 W output power.

Digipower board

The digipower board converts the VBUS to +5V. It supplies the CPU and display controller boards.

The powerup and voltage monitoring circuit on the board provides a reset signal to the CPU and display controller boards. The CPU must refresh the watchdog once every second otherwise a reset signal is sent to the CPU.

Connectors for the A-FGC1 and A-EV1 contain VBUS voltage and serial communication lines.

The board also contains RS232 buffers for external serial communication.

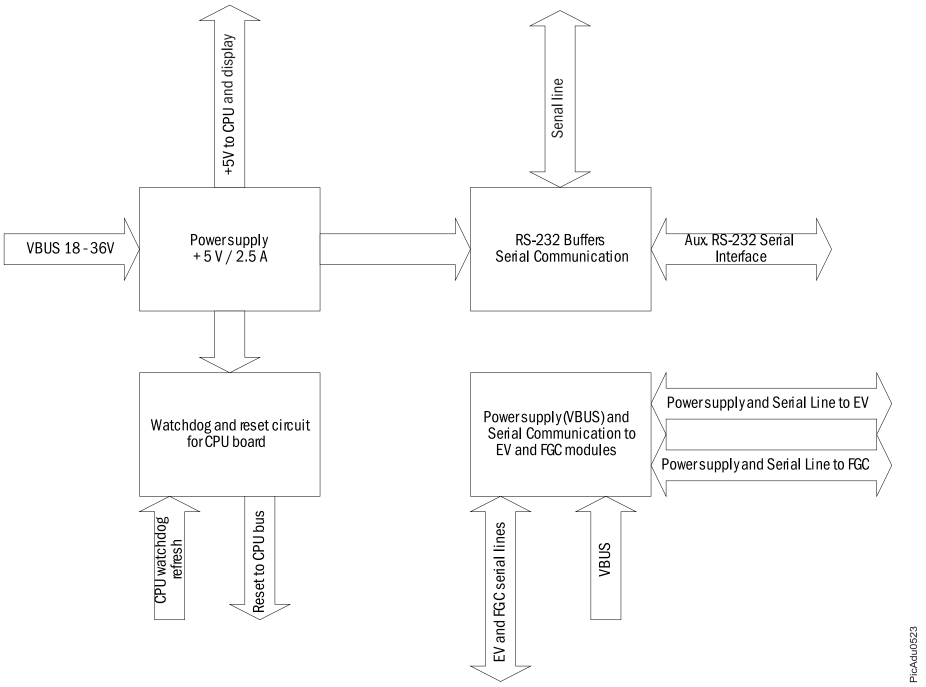

+5V to CPU and display
Serial line
VBUS 18 - 36V
Power supply + 5 V / 2.5 A
RS-232 Buffers Serial Communication
Aux. RS-232 Serial Interface
Watchdog and reset circuit for CPU board
Power supply (VBUS) and Serial Communication to EV and FGC modules
Power supply and Serial Line to EV
Power supply and Serial Line to FGC
CPU watchdog refresh
Reset to CPU bus
EV and FGC serial lines
VBUS
PicAdu0523

Figure 8 Digipower board

CPU board B-CPU4

The B-CPU4..01 is made with PC-technology components. Radisys chipset and PLD handle all timings and signaling for an internal ISA bus. With B-CPU4..01 there is no external software cassette.

Instead there is onboard flash memory where software is loaded from a PCMCIA-card. The B-CPU4..01 takes care of the ADU central processing.

The main features of the ADU B-CPU4..01 are:

- AMD 486DX4 or 486DX5 processor
- Internal clock frequency 75 MHz
- 16 MB SIMM-DRAM
- 4 MB program flash memory
- 8 kB static RAM with real time clock
- 64 kB EEPROM memory
- 2 + 2 channels UART:
  - 3 serial channels with signals in AC-logic level
  - 1 serial channel signals in RS232-level
- Programmable alarm sound generator
- PCMCIA slot for software updates

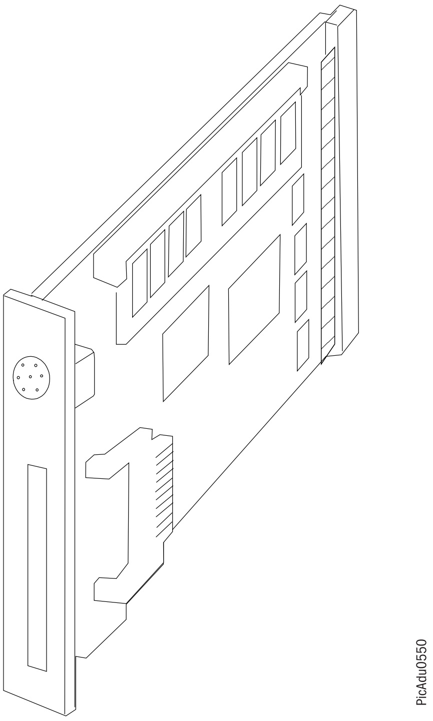


Figure 9 The CPU board B-CPU4..01

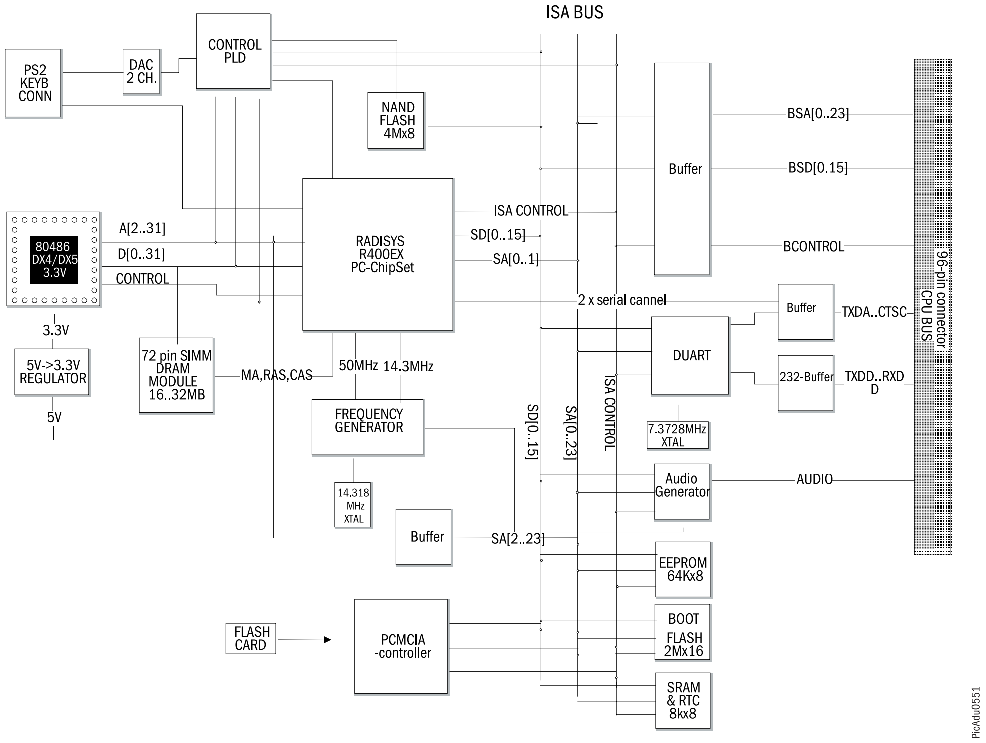

ISA BUS
PS2 KEYB CONN
DAC 2 CH.
CONTROL PLD
NAND FLASH 4Mx8
Buffer
BSA[0..23]
BSD[0.15]
BCONTROL
96-pin connector CPU BUS
80486 DX4/DX5 3.3V
A[2..31]
D[0..31]
CONTROL
RADISYS R400EX PC-ChipSet
ISA CONTROL
SD[0..15]
SA[0..1]
2 x serial cannel
Buffer
TXDA..CTSC
DUART
232-Buffer
TXDD..RXD D
3.3V
5V->3.3V REGULATOR
5V
72 pin SIMM DRAM MODULE 16..32MB
MA,RAS,CAS
50MHz
14.3MHz
FREQUENCY GENERATOR
SD[0..15]
SA[0..23]
ISA CONTROL
7.3728MHz XTAL
Audio Generator
AUDIO
14.318 MHz XTAL
Buffer
SA[2..23]
EEPROM 64Kx8
BOOT FLASH 2Mx16
FLASH CARD
PCMCIA -controller
SRAM & RTC 8kx8
PicAdu0551

Figure 10 **Block diagram of the B-CPU4..01**

Control logic

I/O decoding and wait state generation takes place in the RADISYS R400EX chip and in the EPM7128 PLD.

Hardware watchdog

An external watchdog circuit is located on the digipower board to supervise the program execution and issues a reset pulse if the CPU stops. If a reset occurs, the ADU display will give the alarm *´Unexpected reset´* in order to prevent false information to be displayed on the screen.

SRAM M48T18

Lithium battery back-up 8 kB static RAM with a real-time clock.

CAUTION The IC contains a lithium battery. Discard the battery according to local regulations.

Software loading to the B-CPU4..01

A PCMCIA card is used for updating software on the B-CPU4..01 board. The boot-SW is used to start the system and load the main-SW from the PCMCIA card to the NAND flash. The main-SW is copied to the DRAM by the boot-SW prior to execution.

The ADU Service software card (PCMCIA) is a 4MB flash memory card that includes the ADU Main software. It is intended to use in service purpose to download to the ADU processor board B-CPU4..01 memory. The ADU software card can include 58 licenses, meaning that one software card can be used for downloading the ADU Main software to 58 different ADU B-CPU4..01 boards.

CAUTION The software card is not write protected. Do not use the software card in any other applications other than the ADU.

You can load the software to 58 ADU B-CPU4..01 board from the Software Card. If the loading for some reason would fail, the software can be loaded again to the same CPU..014 board, without consuming a new license.

During the loading of the software is there a unique electronically number written from the CPU board to the Software Card.

For every new CPU board the software is downloaded to will a new license on the Software Card be used.

CPU board B-CPU2

The CPU board handles the central processing.

The main features of the CPU board are:

- 80486SLC processor
- Clock frequency 32 MHz
- Software cartridge interface
- 2 Mbyte DRAM
- 8 Kb battery backed up SRAM with real time clock
- 32 Kb EEPROM memory
- 4 channel UART:
    - 3 channels with handshake signals in AC-TTL logic level
    - 1 channels without handshake signals in RS232 level
- Programmable alarm sound generator
- 5 external and 3 internal interrupts

Control logic

I/O decoding and wait state generation takes place in GAL IC as well as in the processor itself. The code memory (FLASH) and working RAM (DRAM) are designed to be linear, and static RAM and EPROM are mapped in I/O space.

Wait state generators

The processor and the GAL IC have internal wait state generators for their predecoded chip select pins. The other boards connected to the CPU bus also use the wait state generator in the GAL IC.

Halt detection

When the hardware detects HALT nstruction all CPU signals as well as all the outputs to the mother board are left floating in high impedance state. Only DRAM refreshment cycles continue to occur. The HALT state will continue until a reset pulse from the digipower board is received.

External bus

External bus signals are AC-TTL logic level signals. Series resistors are used to limit signal ringing when the signals change status. Additional signal filtering is performed in the mother board.

Main peripherals

QUART 82C684
Four series channel Quart is used.

Sound chip SAA1099
IC SAA1099 is used as alarm sound generator.

SRAM M48T18
Lithium battery backed up 8 Kilobyte static RAM with a real-time clock.

CAUTION The IC contains a lithium battery. Discard the battery according to local regulations.

Refresh watchdog

The processor must periodically refresh the watchdog timer on the digipower board to prevent reset pulses.

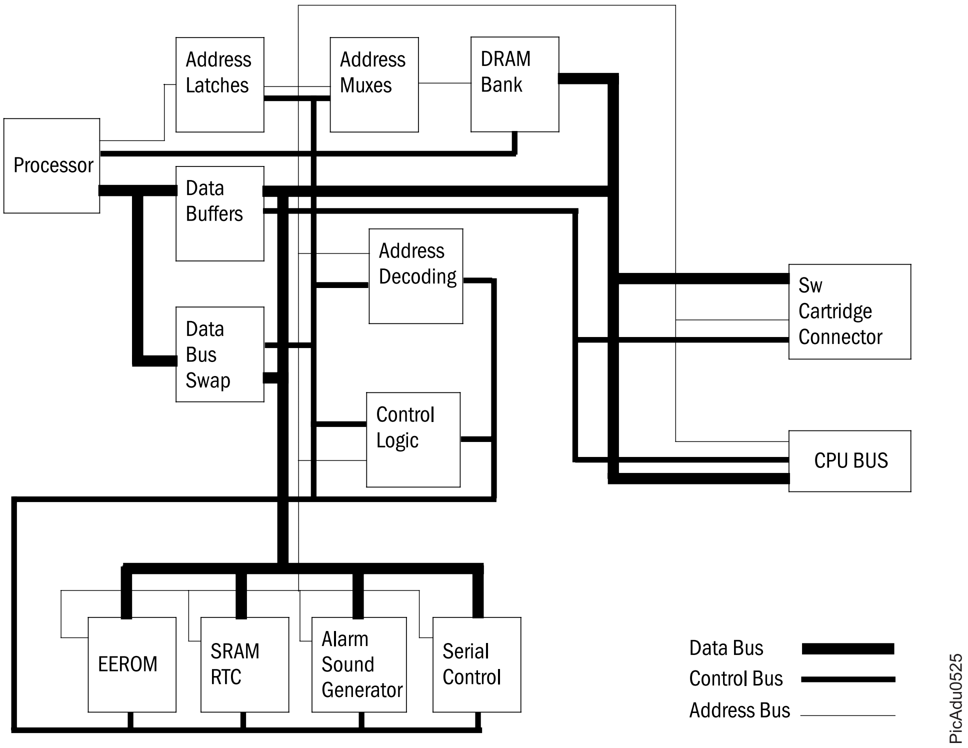

Address
Latches
Address
Muxes
DRAM
Bank
Processor
Data
Buffers
Address
Decoding
Data
Bus
Swap
Control
Logic
Sw
Cartridge
Connector
CPU BUS
EEROM
SRAM
RTC
Alarm
Sound
Generator
Serial
Control
Data Bus
Control Bus
Address Bus
PicAdu0525

Figure 11 CPU board block diagram

Software cartridge

The software cartridge contains the ADU Main software for the B-CPU2 board.

CAUTION The software cartridge cannot be disassembled. There are no serviceable parts inside.

Display controller board B-DISP

Specifications

Video output: both connectors and both resolutions, analogue RGB, 0.2V - 1.1V, 0.8 V_{pp}, 75 ohm

Output data

Resolution	1984 × 512 pixels
Frame frequency:	65 Hz
Scan frequency:	34,7 kHz
Dot frequency:	80 MHz
Sync polarity:	H/negative, V/negative, level TTL

Sync pulse		
	Horizontal	Vertical
Front porch	0.40 µs	57.6 µs
Sync pulse width	1.20 µs	115.2 µs
Back porch	2.40 µs	460.8 µs

VGA resolution output data

Resolution	640 × 480 pixels
Frame frequency:	60 Hz
Scan frequency:	31.6 kHz
Dot frequency:	25 MHz
Sync polarity:	H/negative, V/negative, level TTL

Sync pulse:		
	Horizontal	Vertical
Front porch	0.640 µs	0.349 ms
Sync pulse width	3.520 µs	0.063 ms
Back porch	1.920 µs	1.019 ms

Functional description

B-DISP board is connected to the mother board. The processor on the CPU board downloads program through the CPU bus to B-DISP board.

System memory

The system memory contains the GSP software code. The memory consists of two 256k x 16 memory banks

Frame memory

The frame memory contains digital display data. The size of the memory is 1 Mbyte making 1984 x 512 display resolution with 256 colors possible. The memory consists of four 256k x 8 VRAM memory circuits.

Video interface palette

The video interface palette reads the digital display data from the frame memory and converts the data into analogue RGB-signals. The synchronization signals for the conversion are generated by the GSP.

The video interface palette is clocked by two pixel clocks. A 25 MHz clock is selected for VGA resolution and a 40 MHz clock is selected for high resolution. The 40 MHz clock is internally converted into a 80 MHz clock.

Graphics system processor (GSP)

There are four 16-bit registers in the GSP to which the host processor reads and to writes data.

Display controller resolution

The resolution of the display controller depends on initialization of the GSP's registers and frequency of the video oscillator.

Reset signal

Reset signal comes from the digipower board through the mother board.

Monitor ID register

The monitor ID register contains a three bit (numeric values 0-7) monitor ID code. The register is connected to pins 11-13 of the X3 D-connector. If no display is connected to the B-DISP board or if the monitor ID code fails, 111 code is generated by pull-up resistors. If the ID code is 011 or 101, VGA resolution is selected, otherwise high resolution is selected.

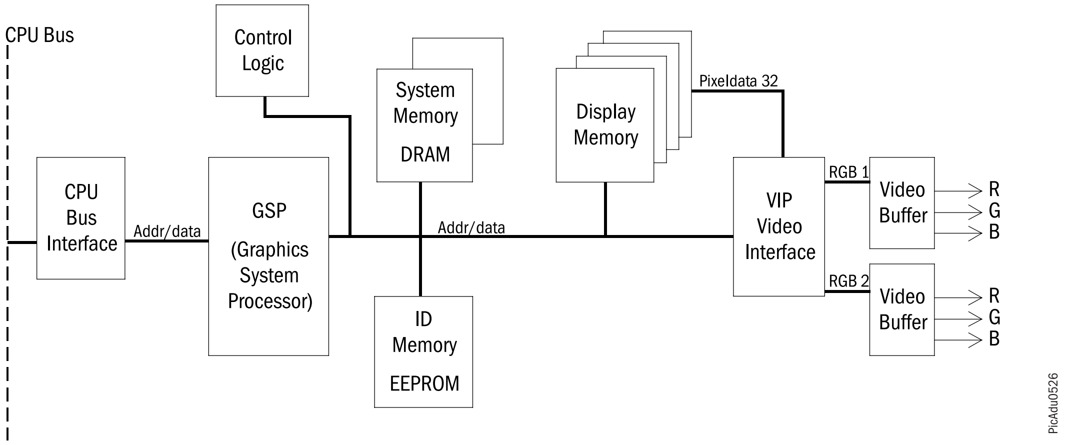

CPU Bus
Control Logic
System Memory DRAM
Display Memory
Pixeldata 32
CPU Bus Interface
Addr/data
GSP (Graphics System Processor)
Addr/data
VIP Video Interface
RGB 1
Video Buffer
R
G
B
RGB 2
Video Buffer
R
G
B
ID Memory EEPROM
PicAdu0526

Figure 12 **Display controller board B-DISP block diagram**

Connectors and signals B-DISP

15-pin D-connector on Display Controller Board, B-DISP, X2

Pin No	I/O	Signal	Notes
1	O	RED VIDEO 1	analogue
2	O	GREEN VIDEO 1	analogue
3	O	BLUE VIDEO 1	analogue
4	I	MON1ID2	monitor identification
5	-	GND	
6	O	RED GND	
7	O	GREEN GND	
8	O	BLUE GND	
9	-	N/C	
10	O	SYNC GND	
11	I	MON1ID0	monitor identification
12	I	MON1ID1	monitor identification
13	O	HSYNC 1	TTL, CMOS
14	O	VSYNC 1	TTL, CMOS
15	-	N/C	

26-pin D-connector on Display Controller Board, B-DISP

Pin No	I/O	Signal
1	O	Red video (analogue)
2	O	Green video (analogue)
3	O	Blue video (analogue)
4	I	MON2ID2
5	I	MON2ID1
6	–	Ground
7	I	MON2ID0
8	O	Horizontal sync
9	O	Vertical sync
10	O	Red ground
11	O	Green ground
12	O	Blue ground
13	O	Ground
14	O	Ground/Sync ground
15	O	+5 V
16	I	On/Standby
17	O	Ground
18	O	Ground
19	I	RxD RS232
20	O	TxD RS232
21	O	Brightness
22	O	Contrast
23	O	Audbufout
24	-	Not connected
25	O	18 – 36 VDC
26	O	18 – 36 VDC

LCD Display D-LCCADU (Rev. 00, -01)

Specifications

General	
Display size	10.4 inch
Display type	Active matrix color LCD
Resolution	640 x 480 (R,G,B)

Dimensions	
Outline (ComWheel included) (W × D × H)	315 × 74 × 265.5 mm / 12.4 × 2.9 × 10.5 in
Weight	3.5 kg / 7.7 lb.

Electrical requirements	
B-DISP	
Power consumption	Approx. 14 W

Environmental requirements	
Operating temperature	10 - 35 °C / 50 - 95 °F
Storage temperature	-10 - 50 °C / 14 - 122 °F
Atmospheric pressure	500 - 800 mmHg (660 - 1060 mbar)
Humidity	0 - 85% non-condensing

Functional description

CAUTION The LCD display backlight inverter board runs on a high voltage. Do not touch the board when power is on.

The LCD Display, D-LCCADU includes LCD Display module, LCD Interface board, and Command Board with keyboard.

The LCD Display is connected to B-DISP display controller board with the interface cable.

Video signaling between the B-DISP or B-DVGA display board and the LCD Display takes place in analogue form (in 00-02 revisions it was in digital form). Incoming signals are buffered in the LCD-interface board and fed forward to the LCD Display module.

Communication between the Display controller board and the Command Board takes place in RS232 serial communication channel D.

NOTE: B-DVGA rev. 01 and rev. 02 do not support D-LCCADU-XX-00. -01.
D-LCCADU-XX-00 requires B-DISP or B-DVGA rev. 03.

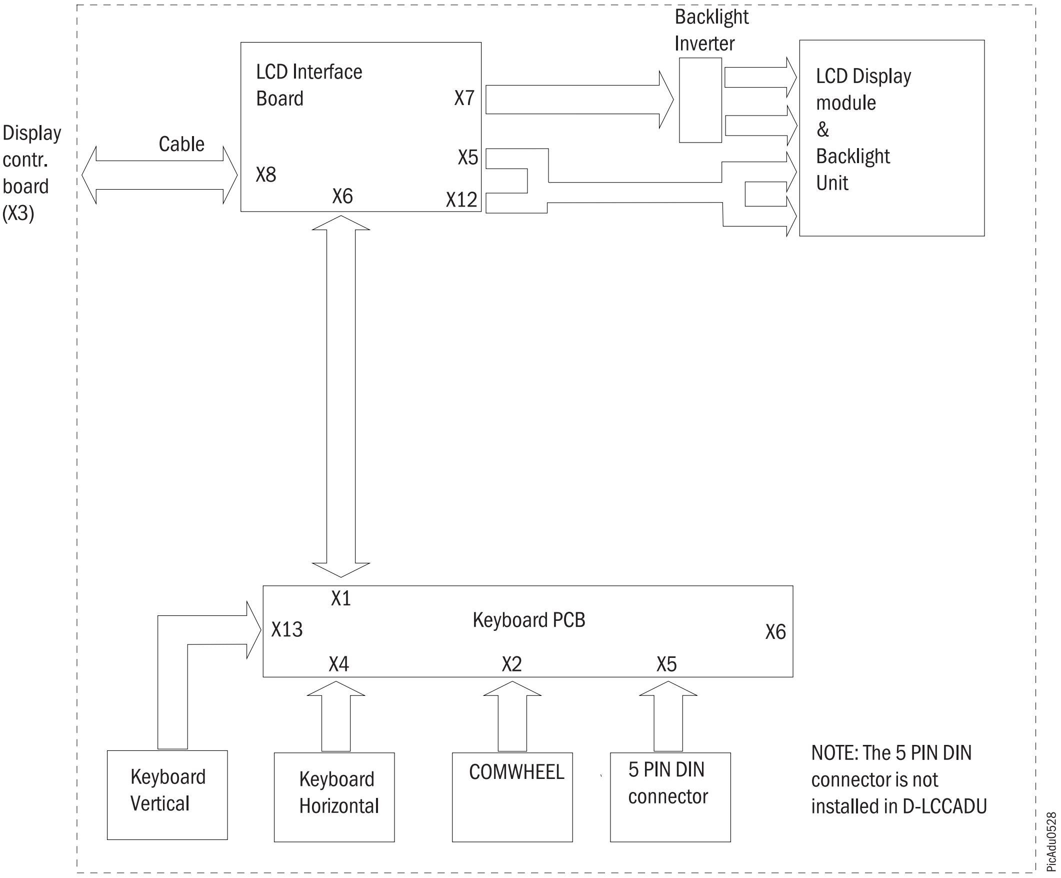

Display contr. board (X3)
Cable
LCD Interface Board
X8
X6
X7
X5
X12
Backlight Inverter
LCD Display module & Backlight Unit
X1
Keyboard PCB
X13
X6
X4
X2
X5
Keyboard Vertical
Keyboard Horizontal
COMWHEEL
5 PIN DIN connector
NOTE: The 5 PIN DIN connector is not installed in D-LCCADU
PicAdu0528

Figure 13 LCD block diagram

LCD interface board

General

The LCD Interface board is the interface between the Display controller board and the LCD Display component. The keyboard is also connected to the Interface board as seen on the preceding diagram.

The incoming signal to the LCD Interface board is pure analogue VGA - RGB with separate horizontal and vertical synchronization signals as seen on the following diagram. The display element needs digital RGB-signals, HSYNC, VSYNC, DOTCLK and a display timing signal DTMG. The DTMG signal indicates that the digital RGB-signals are active.

The functions of this board are digitalization of the video signals, regeneration of the DOTCLK and generation of the DTMG. The backlight driver is also located on this board.

Power supply

The DC/DC power supply is an isolated discontinuous mode flyback switcher. It has a current mode PWM circuit and a separate FET switch on the primary side. The transformer has two secondary windings, one for 5V and another for 12V. On the secondary side (5V), there is a separate chip on the feedback path to drive the opto isolator.

Backlight unit

The backlight unit consists of two changeable tubes fed by a separate inverter board.

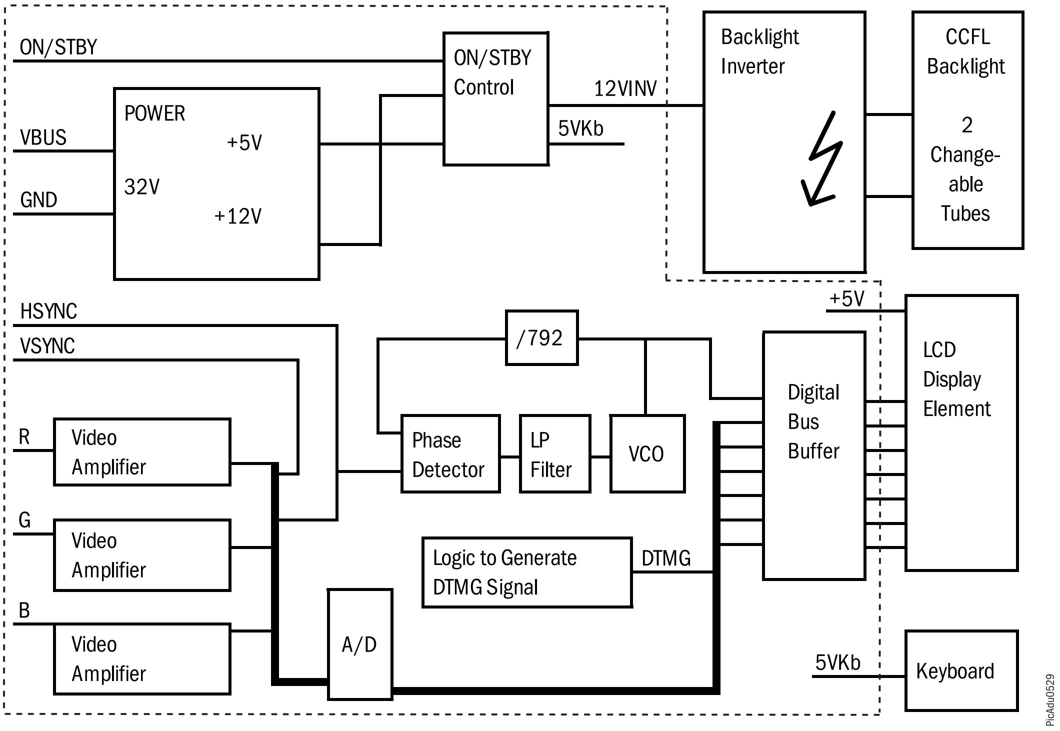

ON/STBY
VBUS
GND
POWER
+5V
32V
+12V
ON/STBY Control
12VINV
5VKb
Backlight Inverter
CCFL Backlight
2 Change-able Tubes
HSYNC
VSYNC
+5V
/792
Digital Bus Buffer
LCD Display Element
R
Video Amplifier
G
Video Amplifier
B
Video Amplifier
Phase Detector
LP Filter
VCO
Logic to Generate DTMG Signal
DTMG
A/D
5VKb
Keyboard
PicAdu0529

Figure 14 LCD interface board block diagram

External connector configurations

The LCD Display has one external connector. Main connector is situated at the back. It is 13 pin Coax D-connector and has pins for operating voltage (18 – 36 VDC), display signals, and serial communication RS232.

LCD Display 13 pin Coax D-connector (main connector)			
Pin No	**I/O**	**Signal**	**Notes**
1	I	Dirty Ground	
2	I	Intensity	
3	I	Hsync2	horizontal deflect
4	I	Vsync2	vertical deflect
5	I	Contrast	
6	I	18 – 36 VDC	
7	I	GND	
8	O	RXDD RS232	from keyboard
9	I	TXDD RS232	to keyboard
10	I	On/Standby	active when low
A1	I	Blue GND & Blue video 2	
A2	I	Green GND & Green video 2	
A3	I	Red GND & Red video 2	

26-pin male D-connector at the end of Interface cable (ADU, Display controller board side)

Pin No	I/O	Signal	Notes
1	O	RED VIDEO2	
2	O	GREEN VIDEO2	
3	O	BLUE VIDEO2	
4		BLANK	not used
5			
6	O	GND	chassis
7			
8	O	Hsync2	horizontal deflect
9	O	Vsync2	vertical deflect
10	O	RED GND	
11	O	GREEN GND	
12	O	BLUE GND	
13	O	GND	chassis
14	O	DCLK GND	
15		not connected	
16		On/Standby	GND
17	O	Dirty GND	
18	O	Dirty GND	
19	I	RXDD RS232	from keyboard
20	O	TXDD RS232	to keyboard
21		not connected	
22		not connected	
23		not connected	
24		not connected	
25	O	18 – 36 VDC	
26	O	18 – 36 VDC	

REPAIR INSTRUCTIONS A-ELEC

General procedures before and after repair of the A-ELEC module

CAUTION During any handling of circuit board make sure that you maintain protection against electrostatic discharge (ESD).

CAUTION Handle the electronics parts carefully by always using electrostatic discharge protection bags for storage of the parts.

Necessary tools: *Standard tools described in the TRM.*

The following can be replaced without taking out the A-ELEC from the ADU frame:

- CPU board (both B-CPU2 and B-CPU4)
- Digipower board
- Display controller board, B-Disp
- Software cartridge (applies to A-ELEC with B-CPU2)
- Downloading software with PCMCIA card (applies to A-ELEC with B-CPU4)

Procedure before repair

1. Turn the ADU Off and disconnect the main power.
2. Disconnect pipeline supplies; close cylinder valves.
3. Remove the ADU back cover by unscrewing the (8) Allen screws.

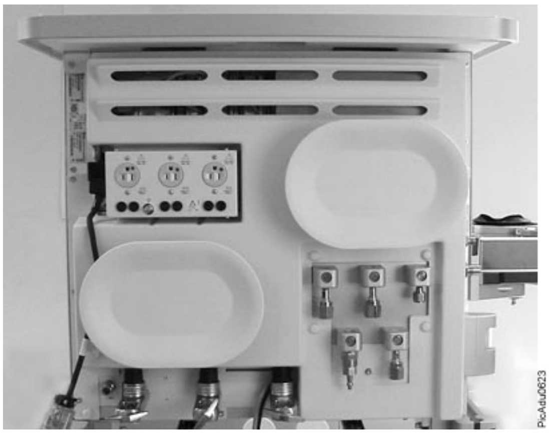


Figure 15 The back cover

4. Remove the Auxiliary outlet box A-EO (2) Allen screws.

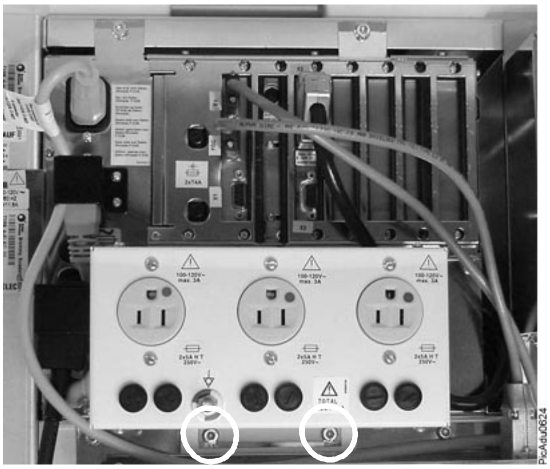


Figure 16 The auxiliary outlet box

Procedure after repair

1. Reinstall the covers
2. Reconnect the pipeline pressure and mains power
3. Perform the Central Electronics section of the Functional Check, refer to part I chapter 5
4. Perform the System Checkout

Removing and installing the A-ELEC from the ADU frame

Procedures

1. Remove the ADU frame left side cover see the figure below.

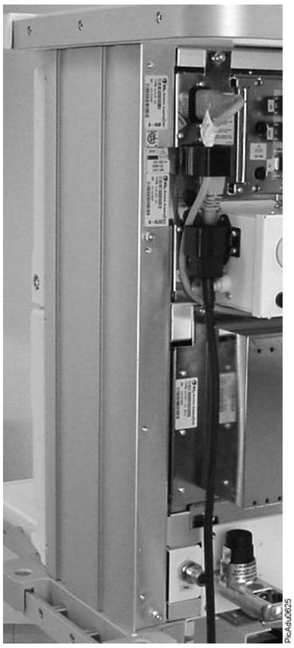


Figure 17 The frame left side cover (view from behind)

2. Remove the left hand side frame panel (viewed from the back of ADU) and disconnect On/Standby switch cable from the according to figures below.

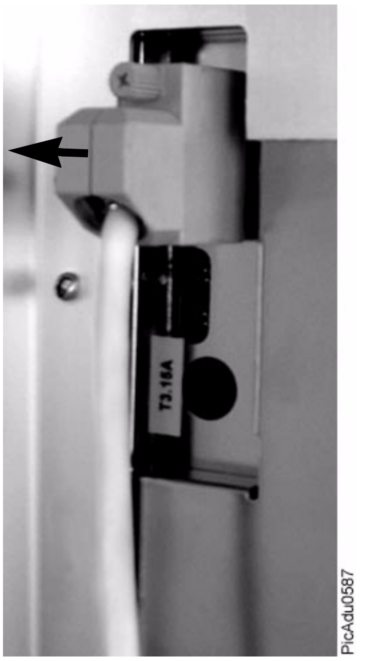


Figure 18 Disconnecting the On/Standby switch cable

3. Remove the four Allen screws as figure below and lift out the A-ELEC.

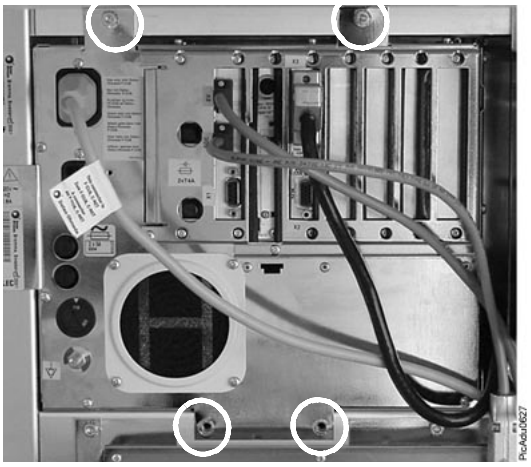


Figure 19 Removing four Allen screws

4. To reinstall A-ELEC to frame perform step 1-3 in reverse order.

Replacing the CPU board (B-CPU4 and B-CPU2)

NOTE: After installing a new CPU board the ADU will re-load factory default configurations.

Upon completion of this procedure:

- The country and user specific configurations must be reconfigured after installing a new CPU board (Ref: TRM part I section 4 Installation Instructions, also the User Reference Manual section 4).
- The event and error logs, system running hours, gas usage data and ADU serial number will be set to zero (A-AUF ID number will always be zero (O) in electronic form on the service menu).

Procedures

1. Disconnect all interfacing cables connected to the CPU board, Digipower board and the Display controller board.

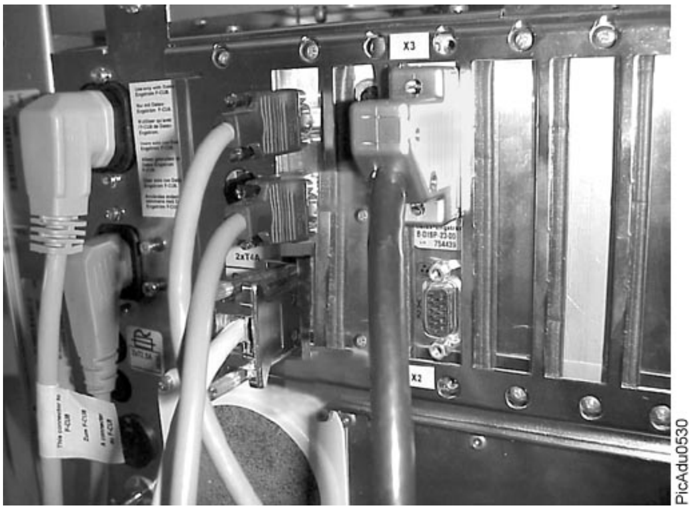

X3
2xT4A
X2
PicAdu0530

Figure 20 Cable connections

2. Remove the EMC grid plate by unscrewing the three Pozidriv screws.

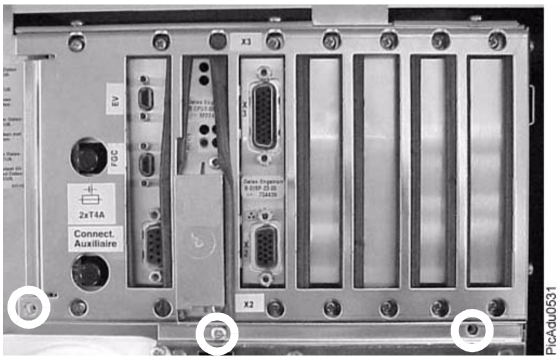

X3
EV
FGC
2xT4A
Connect.
Auxiliaire
X2
PicAdu0531

Figure 21 EMC grid plate securing screws

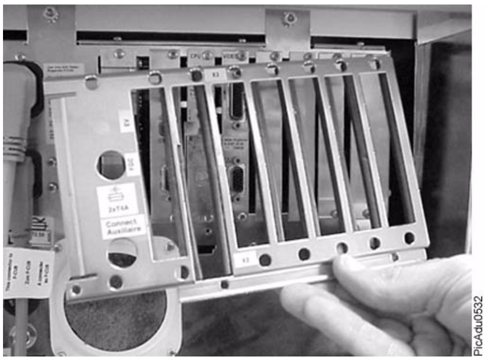

X3
EV
FGC
2xT4A
Connect.
Auxiliaire
X2
PicAdu0532

Figure 22 EMC grid plate

3. Loosen the two Pozidriv screws that secure the “old” B-CPU board and remove it. Install the new B-CPU board and secure it with the two previously removed Pozidriv screws according to figures below. Note that B-CPU4 not include the software cartridge.

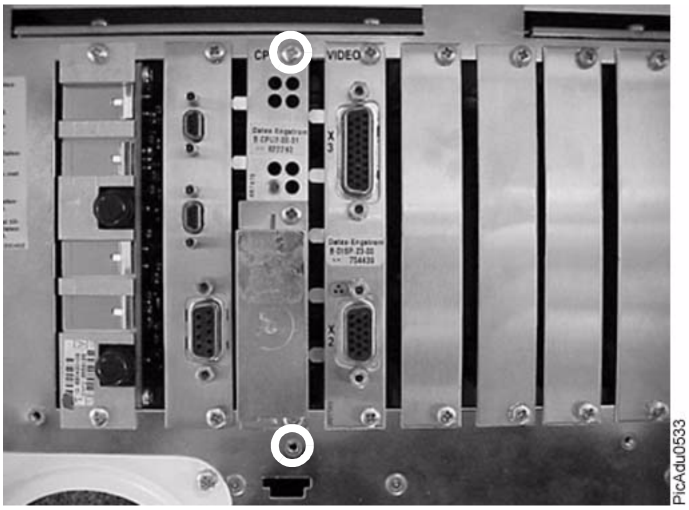


Figure 23 **B-CPU2 board securing screws**

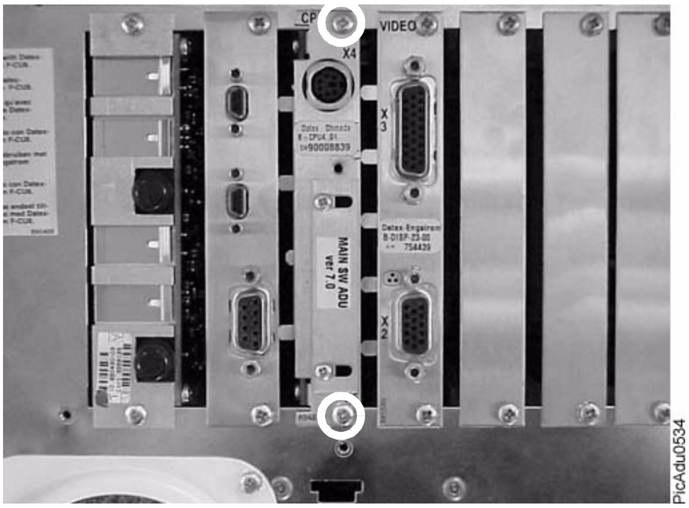


Figure 24 **B-CPU4 board securing screws**

4. Install the new CPU board and make sure that the board get correct contact to the connector in the mother board.
5. Reinstall the EMC grid plate, cables and back cover in reverse order.
6. Reconnect the gas supply and mains power.
7. Turn on the ADU and verify the software version number apples on the ADU display during start-up.
8. Perform User configuration.

NOTE: All new B-CPU boards come configured with factory defaults. This means the O_2 flow bar will be on the left side of the N_2O flow bar, also the gas colors may be different.
To change the flow bar location it is necessary to have the distributor password.
To change the colors on flow bars it is necessary to have the factory password.

Downloading the ADU main software with PCMCIA card to B-CPU4

NOTE: After installing the software the ADU will re-load factory default configurations.

Upon completion of this procedure:

- The country and user specific configurations must be reconfigured (See *“Section 4 Installation instructions”* and *“User´s Reference Manual, section 4”*).

Installation procedure

1. Loosen the two Pozidriv screws that secure the cover of the card drive slot on the B-CPU4..01 circuit board and slide the cover to the left.

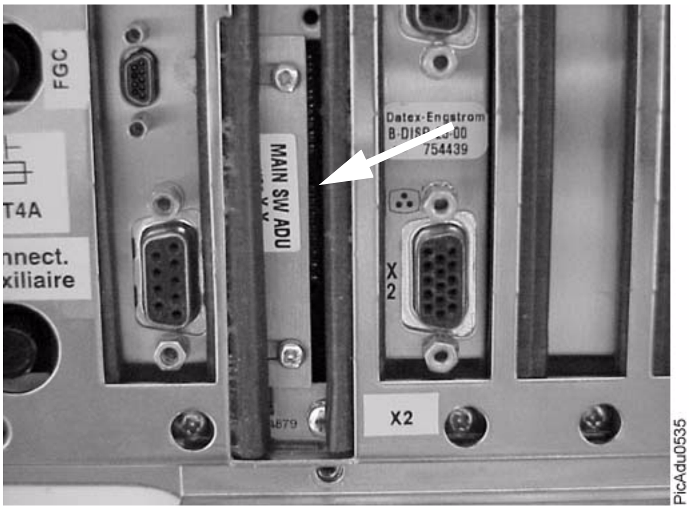

FGC
T4A
nnect.
xiliaire
MAIN SW ADU
Datex-Engstrom
754439
X
2
X2
PicAdu0535

Figure 25 Card drive slot location

2. Insert the software card into the card drive slot as shown below, and firmly push the card in position. Do NOT use excessive force!

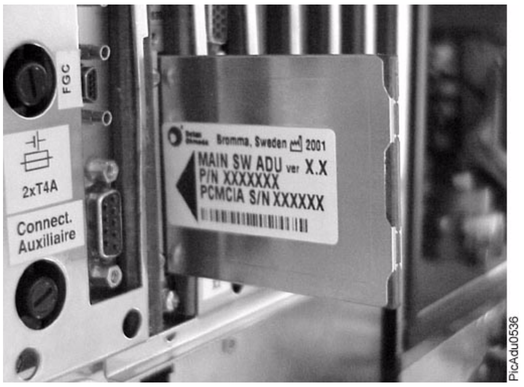

FGC
2xT4A
Connect.
Auxiliaire
Bromma, Sweden 2001
MAIN SW ADU ver X.X
P/N XXXXXXX
PCMCIA S/N XXXXXX
PicAdu0536

Figure 26 Inserting the PCMCIA card

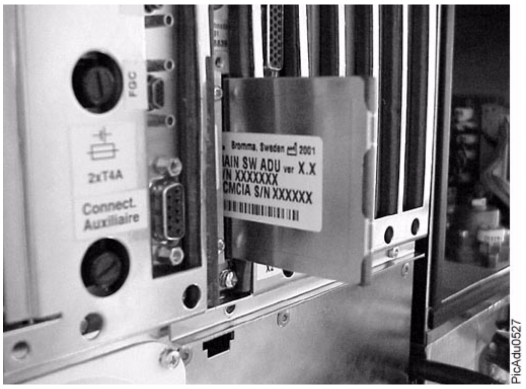
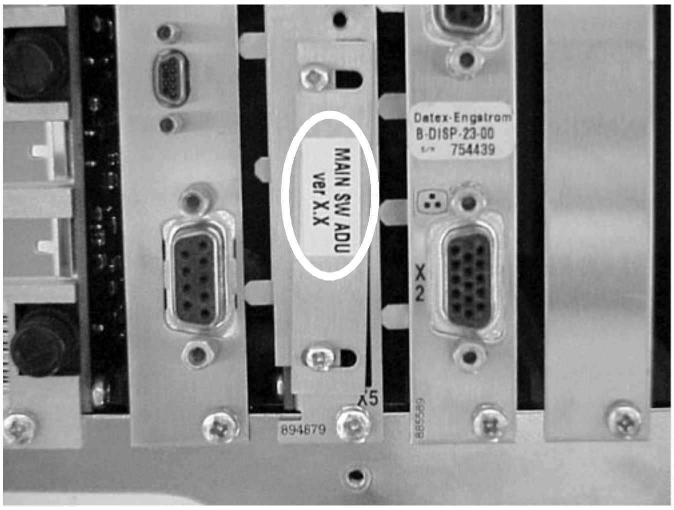

FGC
2xT4A
Connect.
Auxiliaire
Bromma, Sweden 2001
AIN SW ADU ver X.X
/N XXXXXXX
CMCIA S/N XXXXXX
PicAdu0527

Figure 27

3. Reconnect the gas supply and mains power. Turn on the ADU.
4. After 30-80 seconds, verify the Main software version number displayed on the start-up screen agrees with software version number on the PCMCIA card. If not, turn off the ADU and verify the card is correctly installed.
   Note: The version number can also be checked in the ADU service view.
5. Turn ADU mains Off and remove the software card.

6. Disconnect the gas supplies.
7. Slide the drive card cover back and tighten the two Pozidriv screws, which secure the cover.
8. Apply the self-adhesive label that is supplied with the kit onto the drive card cover.



PicAdu0537

Figure 28 Label location

9. Document the A-AUF ID and B-CPU4..01 serial numbers on the log sheet (last page in this instruction).
10. Re-install the back cover and connect mains power.
11. Reconnect gas supplies and turn on the ADU.
12. Verify that the ADU screen appears normal and no errors are present.
13. Perform user configuration. Refer to the ADU TRM part I chapter 4 Installation instructions/ configuring the software.

NOTE: The PCMCIA card SW has factory default configuration loaded. This means the O_2 flow bar will be on the left side of the N_2O flow bar, also the gas colors may be different. To change the flow bar location it is necessary to have the distributor password. To change the colors on flow bars it is necessary to have the factory password.

14. Perform System Checkout (there are not needed to perform Functional Checkout after down loading software).

Replacement of software cartridge in B-CPU2

Upon completion of this procedure:

- It is not necessary to take out the A-ELEC from the ADU Frame
- The country and user specific configurations must be reconfigured after installing a new Main software cartridge (See section *“Installation Instructions”* and section 4 in the *“User´s Reference Manual”*).

1. Remove the EMC grid plate by unscrewing the three Pozidriv screws.

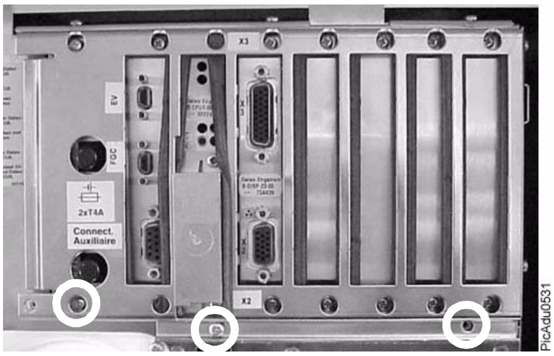

X3
EV
FGC
2xT4A
Connect. Auxiliaire
X2
PicAdu0531

Figure 29 **EMC grid plate securing screws**

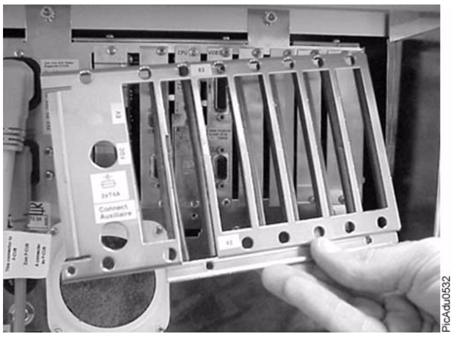

EV
2xT4A
Connect. Auxiliaire
PicAdu0532

Figure 30 **EMC grid plate**

2. Loosen the two Pozidriv screws that secure the software cartridge and remove it.

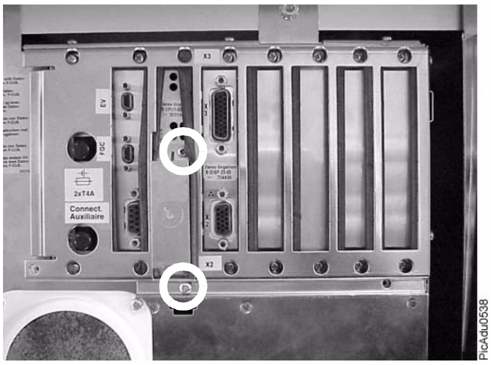

X3
EV
FGC
2xT4A
Connect. Auxiliaire
X2
PicAdu0538

Figure 31 **Software cartridge securing screws**

3. Install the new software cartridge and secure it with the two previously removed Pozidriv screws.
4. Reinstall the EMC grid plate and back cover in reverse order.
5. Reconnect the pipeline pressure and mains power.
6. Turn on the ADU and verify that the new software version number is displayed on the ADU during the start-up.
7. Perform User configuration. Refer to Part I chapter 4.

NOTE: All new Main software comes configured with factory defaults. This means that the O_2 flow bar will be on the left side of the N_2O flow bar, also the gas colors may be different. To change the flow bar location it is necessary to have the distributor password. To change the colors on flow bars it is necessary to have the factory password

8. Perform System Checkout (it is not needed to perform Functional Checkout after replacing the software cartridge.)

Replacing the B-DISP or the Digipower board

1. Disconnect all interfacing cables connected to the CPU board, Digipower board and the Display controller board.

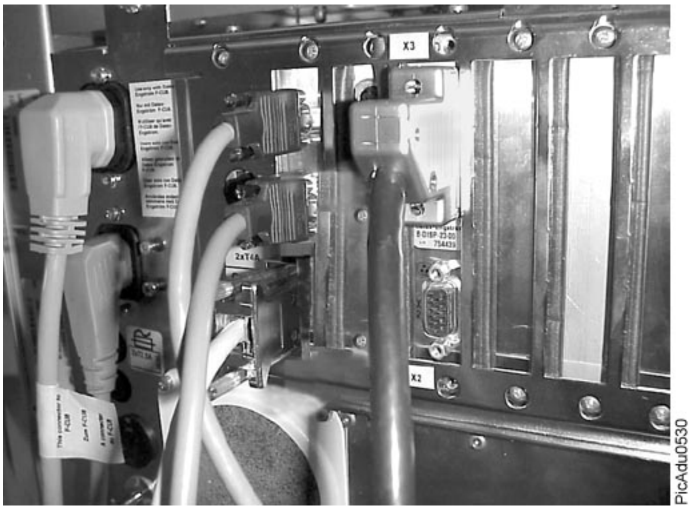

X3
2xT4A
X2
PicAdu0530

Figure 32 Cable connections

2. Remove the EMC grid plate by unscrewing the three Pozidriv screws.

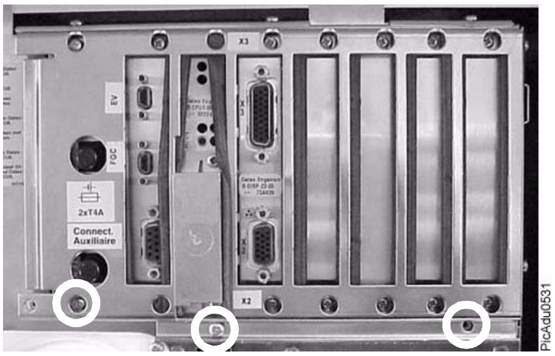

X3
EV
FGC
2xT4A
Connect.
Auxiliaire
X2
PicAdu0531

Figure 33 EMC grid plate securing screws

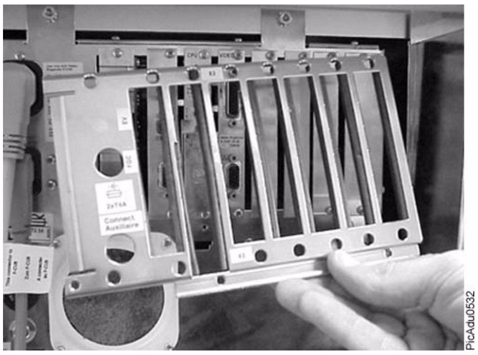

2xT4A
Connect
Auxiliaire
PicAdu0532

Figure 34 EMC grid plate

3. Loosen the two Pozidriv screws that secure the board that shall be replaced and remove it. Install the new board and secure it with the two previously removed Pozidriv screws according to figures below. Make sure that the board get correct contact to the connector in the mother board.

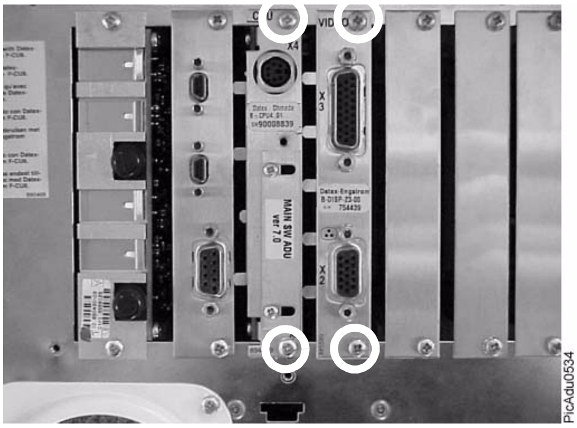


Figure 35 Securing screws for Digipower board (left) and B-DISP board (right).

4. Reinstall the EMC grid plate, cables and back cover in reverse order.

Replacement of the mains board

For replacing the mains board the A-ELEC must be taken out from the ADU frame

1. Remove the top plate from the A-ELEC by removing three screws (1) and unlocking two screws (2) as figure shows below.

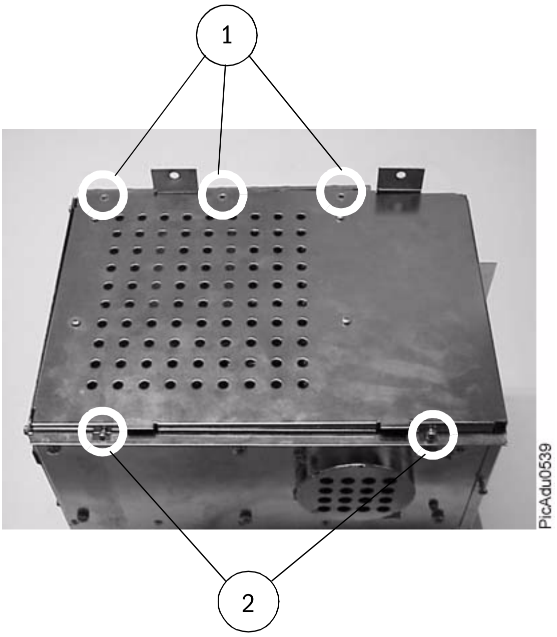


Figure 36 Removing top plate from the A-ELEC

2. Remove the A- ELEC1 side cover by unlocking the 5 screws as shown in figure below

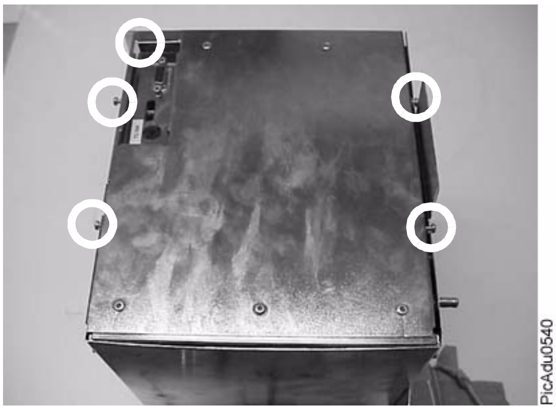


Figure 37 Removing the A- ELEC1 side cover by unlocking screws

3. Remove the 4 screws securing the Main board see figure below.

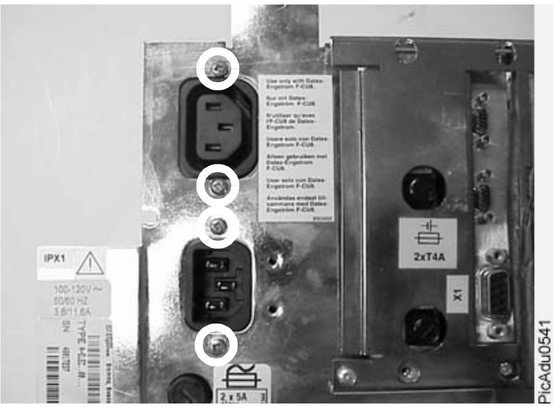


Figure 38 Screws securing the mains board

4. Disconnect the green/yellow cable for the Mains board as figure below.

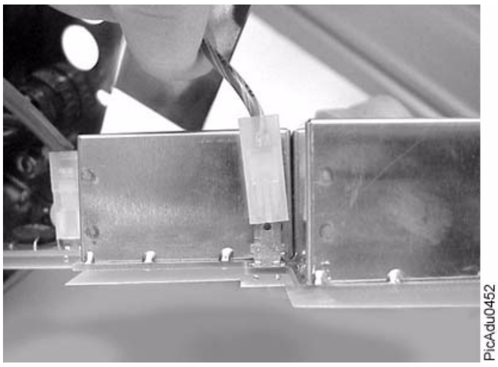


Figure 39 Disconnecting the green/yellow cable from the mains board

5. Disconnect the three transformer cables from the mains board

Transformer cable	Mains board socket connection
Blue	X8
Black	X7
Brown	X6

NOTE: On A-ELEC modules with power conversion kit installed (a label with the text *"8503007 INSTALLED"* is applied on the back of the A-ELEC) has the transformer cables other colors: X8 Blue / X7 Green / X6 White.

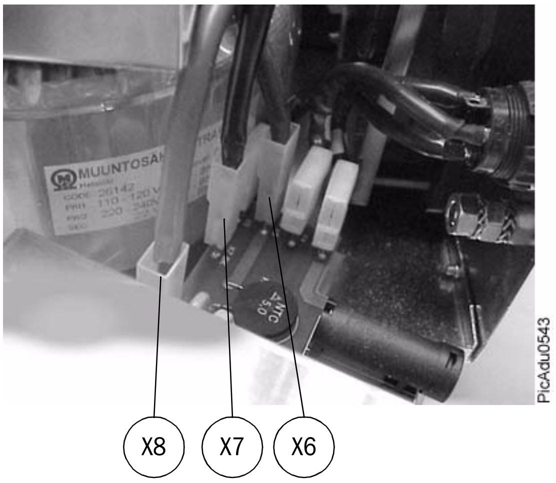


Figure 40 The three transformer cables

6. Disconnect the three remaining cables connected to the Mains board X5 marked 5, X6 marked 4, X7 marked 3.

Transformer cable	Mains board socket connection
No. 5	X5
No. 4	X6
No. 3	X7

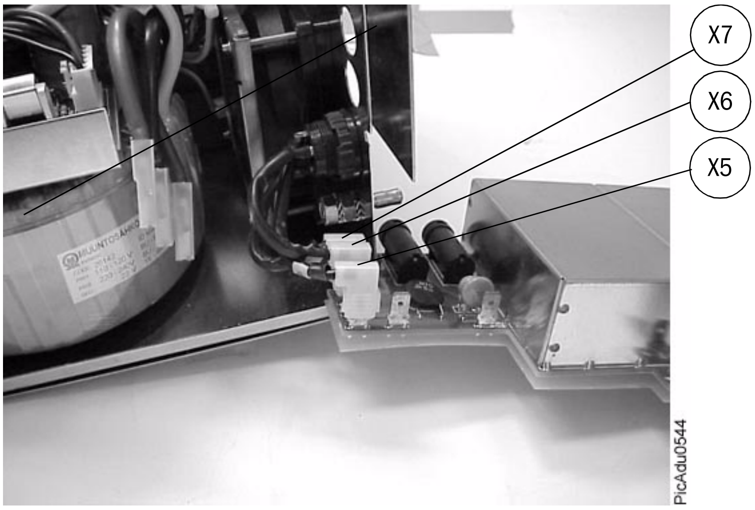


Figure 41 Transformer cables connected to mains board

7. Install the new mains board and covers in reverse order. Make sure that the speaker board is correct installed as figure below shows before reinstalling the covers.

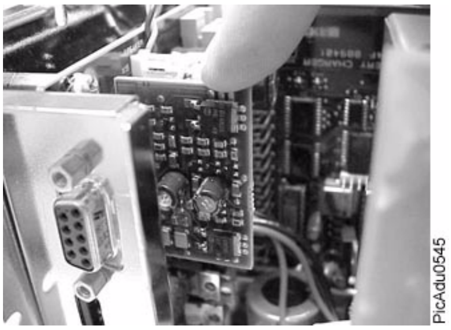


Figure 42 **Speaker board**

Replacement of the rectifier board

For replacing the rectifier board the A-ELEC must be taken out from the ADU Frame

1. Follow steps 1 to 3 in previous instruction *"Replacement of mains board"*.
2. Disconnect the Green/Yellow cable for the mains board (figure below) and put it aside without disconnecting the cables connected to the mains board.

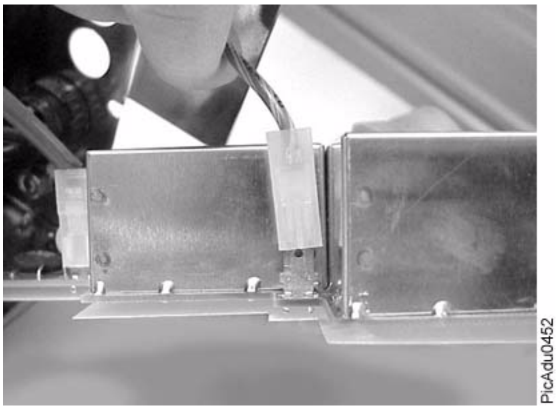


Figure 43 **Disconnecting the green/yellow cable from the mains board**

3. Disconnect the following cables from the connectors on the rectifier board:

Cable	Rectifier board socket connection
Connector with 5 wires	X1
Yellow	X2
Black	X3

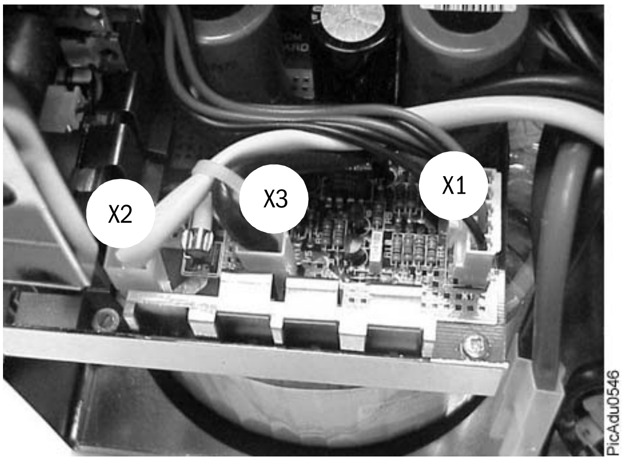


Figure 44 **Rectifier board socket connections**

4. Remove the two screws securing the rectifier board and take out the board from the A-ELEC.

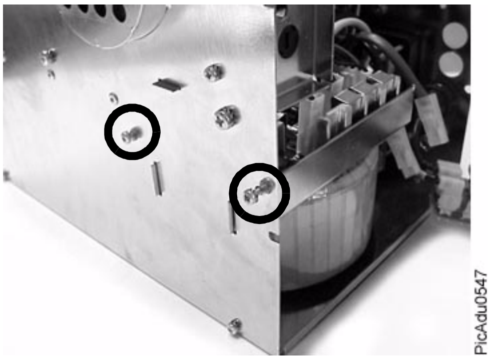


Figure 45 **The screws securing the rectifier board**

5. Remove the rectifier board from the A-ELEC and install a new one.
6. Before reinstalling the covers, make sure that the speaker board is correct installed as the figure below shows.

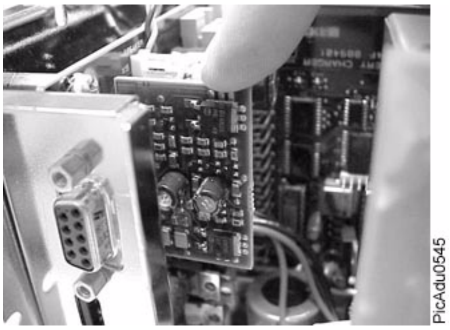


Figure 46 **The speaker board**

Replacement of the battery charger board

For replacing the battery charger board the A-ELEC must be taken out from the ADU Frame

1. Following the step 1 to 2 in previous instruction *"Replacement of Mains board"*.
2. Disconnect the following wires connected to the battery charger board connections X2, X3, X4 and X5.

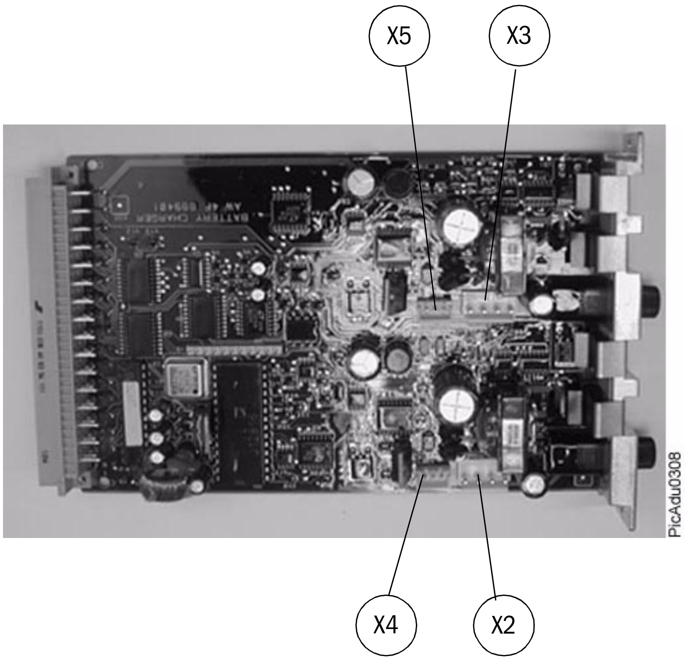


Figure 47 **The battery charger board**

3. Remove the EMC grid plate by unscrewing the three Pozidriv screws.

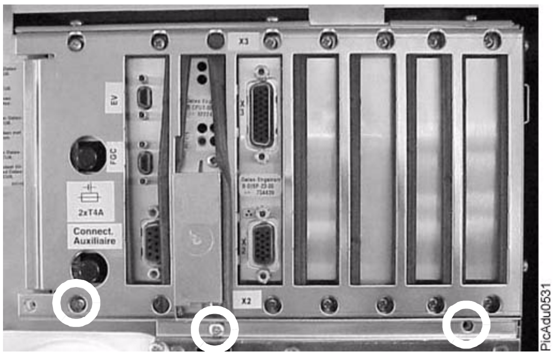


Figure 48 **EMC grid plate securing screws**

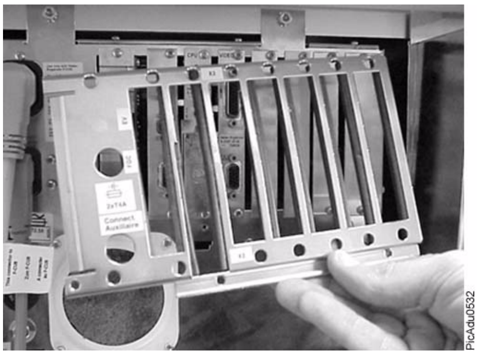


Figure 49 **EMC grid plate**

4. Loosen the two Pozidriv screws that secure the battery charger board and remove it. Install the new board and secure it with the two previously removed screws according to figures below. Make sure that the board get correct contact to the connector in the mother board.

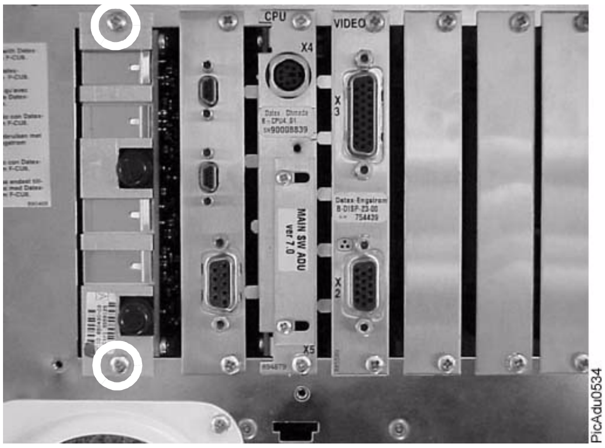


Figure 50 **Screws that secures the battery charger board**

5. Reinstall all parts in reverse order.
6. Before reinstalling the covers, make sure that the speaker board is correct installed as figure below shows.

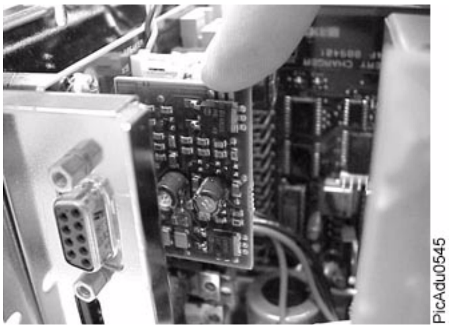


Figure 51 **The speaker board**

Replacement of batteries

Pb Pb

Follow the instructions in the *“Maintenance”* section in this manual.

NOTE: All four batteries must be exchanged at the same time

Repair Instructions for D-LCCADU

General repair information D-LCCADU

The repair instruction in this Manual are limited to:

- Replacement of the display D-LLCADU and D-LCC10W in ADU
- Replacing LCD display element.
- Replacement of back light tubes.
- Replacing key stickers.

For other instruction refer to the exploded views in spare part section of this chapter and Datex-Ohmeda Technical Reference Manual for S/5 TM Anesthesia Monitor.

Repairs for the display D-LCC10W are outlined in the Datex-Ohmeda Technical Reference Manual for S/5 TM Anesthesia Monitor.

Replacement of display D-LCCADU and D-LCC10W

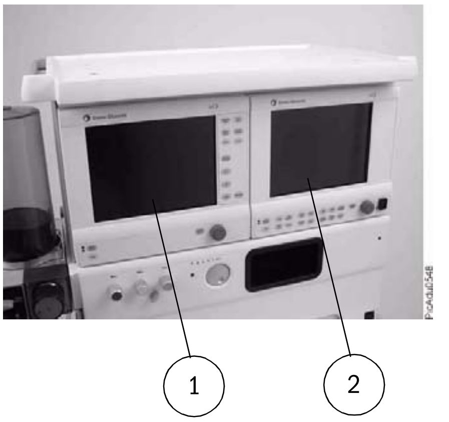


Figure 52 D-LCCADU (1) and D-LCC10W (2)

1. Turn off the ADU and disconnect the mains plug from the wall socket.
2. Remove the top-shelf (4 Allen screws). See figure below.

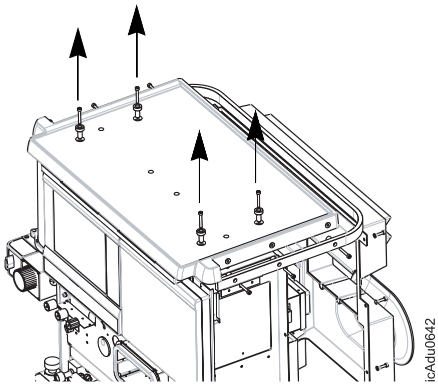


Figure 53 Removing the Allen screws

There are two alternative ways to replace the displays:

A) If the display including its cable shall be replaced, the ADU back cover must also be removed and the display cable be disconnected from the A-ELEC alternative the AM.

B) If only the display shall be replaced, the ADU back cover may not be removed. The display cable shall be disconnected from the display side by removing the display cable cover and then disconnect it.

3. Remove the two screws as the figure shows below from the display that shall be replaced.

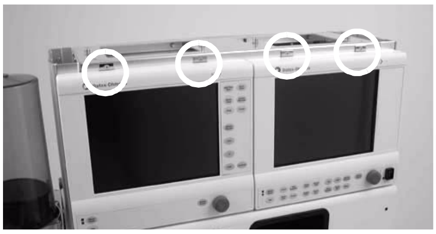


Figure 54

4. Replace the display according to alternative A or B above.
5. Install all parts in reversed order.
6. Perform the Display and keyboard check that is outlined in the Functional Checks (see chapter *"Maintenance"*).
7. Perform a System Checkout.

D-LCCADU LCD display disassembly and reassembly

Disassemble the LCD display according to the following procedure. Please refer to the exploded view of the LCD display.

NOTE: Wear a static control wrist strap and soft cotton gloves (lint free) when handling the LCD Display parts. Do not touch the connector pins.

1. Place the LCD Display on a flat surface with the front side downwards.
2. Remove the screws (x4) in the corners of the rear panel.
3. Lift the rear panel gently, disconnect the cable(s) and put the rear panel aside.
4. The Command board PCB are detached by disconnecting the cable connectors and removing the screws (x2).

Reassembly of the LCD Display is made in reversed order. Make sure that all connectors are properly connected and that the cables are not pinched between the covers.

Replacing the backlight tubes

1. Disconnect the folio cables (2 pcs) by pulling the connector's front part in the direction of the cable.
2. Disconnect the other cables from the LCD interface board.
3. Unscrew 5 screws and pull out the lid.
4. Detach the connector of the backlight tube from the inverter board.
5. Unfasten the two screws which hold the backlight tube and pull it out together with the clamp.
6. Locate the two new backlight tubes, fasten the screws, and connect them to the inverter board.
7. Attach all the parts, and make sure that the folio cables are connected properly. Make sure that the folio cables are routed at the bottom and run straight before locking the connector.

Replacing key stickers

1. Remove the old sticker.
2. Remove the remains of removed sticker and clean the surface with fine spirits (C_2O_5OH).
3. Apply the new sticker.

TROUBLESHOOTING A-ELEC

Error messages from the A-ELEC

Normal operation messages

Message	**Condition**	**Recommended action**
“Charge” In battery icon	Battery capacity test indicates less than 80%	Keep ADU connected to mains power supply. Normal battery charging in progress. Keep the Mains power on for 4h to fully charge the batteries.
Batteries empty Go manual	SHUTDOWN signal is activated. “Empty” –text inside battery icon. LED next to “Silence Alarms” –key is flashing RED.	Make sure that the ADU is connected to mains power and turned on. Follow the battery troubleshooting guide.
Mains power lost	LINE signal status is turned from ON to OFF. Battery icon showing capacity.	Check if the ADU: - Power cord disconnected – mains fuses or the rectifier board fuse are blown – mains over or under voltage. ADU is switched to battery operation. ADU will be switched back to mains voltage operation when mains voltage is back to nominal mains voltage range.
System check bypassed	Bypass Check is selected in System check menu.	Perform Full check or separate test.
Patient monitor removed	Install/Interfacing: Monitor is Gas or Multi. Interface between the ADU and patient monitor is set up but disconnected.	Check in the ADU Install menu that the connection of monitor correctly done. Check interfacing cable between the ADU and monitor is setup correctly.
Volume monitor removed (this message only applies when French version have been set to YES in Install config. Menu	Connection lost between the ADU and the Monitor.	Check in the ADU Install menu that the connection of monitor correctly done. Check interfacing cable between the ADU and monitor is setup correctly.

Error condition messages

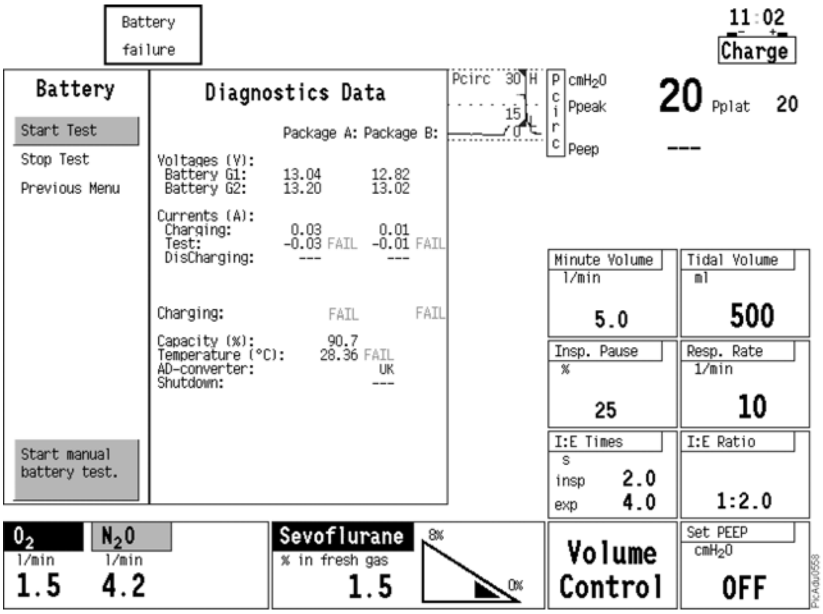
Message in normal screen	Message in diagnostic page	Caused by	Recommended action	Err Log.
Shutdown	HW shutdown act	SHUTDOWN –signal is active when running on mains power (LINE=ON)	Change battery charger board.	
Battery failure	HW charg err A/B	When on mains power the battery pack A, B voltage is less than 26V and charging current less than 0.2A. See also battery failure trouble shooting guide.	Change battery charger board.	X
Battery failure	HW charg cur A/B fail	The battery charging current of pack A, B is more than 1.0A See also battery failure trouble shooting guide.	Change battery charger board.	X
Battery failure	HW test cur A/B fail	During battery test the current drawn from the battery pack A / B is < 0.1A or > 0.3A See also battery failure trouble shooting guide.	Change battery package or battery charger board.	X
Battery failure	HW run cur A/B fail	When running on battery power, the current drawn from battery pack A / B is < 0.1A See also battery failure trouble shooting guide.	Change battery package or battery charger board.	X
Battery failure	HW battery A1/A2 fail	Battery A1 / A2 voltage differs more than 0.5V from the average of the four battery voltages See also battery failure trouble shooting guide.	Change battery package A.	X
Battery failure	HW battery B1/B2 fail	Battery B1 / B2 voltage differs more than 0.5V from the average of the four battery voltages See also battery failure trouble shooting guide.	Change battery package B.	X

Message in normal screen	Message in diagnostic page	Caused by	Recommended action	Err Log.
Battery failure	HW temperature low	The temperature is less than 10°C. See also battery failure trouble shooting guide.	Has ADU been in normal room temperature for over 4 hours? Check battery temperature sensor assemblies.	X
Battery failure	HW temperature high	The temperature is more than 55 degrees. See also battery failure trouble shooting guide.	Is the ambient temperature high? Check that module cooling fan is in operation and dust filter is clean. Change temperature sensor assemblies.	x
	HW AD error		Not applicable / error message appears when mains power is turned ON.	x
System Busy	N/A	System is not yet ready to process new keyboard commands.	Stop pressing keys for a while.	N/A
Un-expected reset in startup screen	N/A	System Reset.	See “Unexpected reset” on page D-45	N/A
Keyboard failure	N/A	“Keyb. failure” –text in is displayed in Ventilation field. LED next to “Silence Alarms” –key is flashing RED.	Check cable to DLCCADU Replace DLCCADU	x
ROM failure	N/A	Check sum error found in the EPROM. Startup screen will stay permanently and the system cannot be operated.	On CPU2 board change the Main SW cassette. On CPU 4 board reload Main SW.	N/A
RAM failure	N/A	Read and write test of RAM fails. Startup screen will stay permanently and the system cannot be operated.	Replace CPU board.	N/A

Message in normal screen	Message in diagnostic page	Caused by	Recommended action	Err Log.
EEPROM error	N/A	NOTE MESSAGE “EEPROM Error” will stay for 60 seconds after startup.	Replace CPU board.	N/A
SRAM error	N/A	NOTE MESSAGE “SRAM Error” will stay for 60 seconds after start-up.	Replace Battery SRAM. Replace CPU board.	N/A
Display error	Display controller fails. Either the card is loose or broken.	Display failure will be reported when the start-up routine cannot copy data to the GSP-board memories. More correct would be Display memory failure. Startup screen will stay permanently and the system cannot be operated.	Replace the display controller board B-Disp.	N/A

Battery failure troubleshooting guide

- when the ADU gives intermittent ‘Battery failure’ message on the main screen the most likely cause is not an actual malfunction in the batteries or on the battery charger board. This document will describe how you can test and determine the root cause of battery problems, with the help of service menus.
- Enter the Diagnostics/ Central Electronics/ Battery menu (see figure next page)
- Try to repeat the problem by:
    1. Starting ***Manual - Battery Test*** from the menu
    2. or with ***Discharge -Recharge Cycling Test***
    3. or disconnecting/connecting mains
- Write down the data values while performing troubleshooting
- Check error conditions from Error History and compare the HW errors to Typical Error Messages
- Verify/compare the results to Typical Diagnostics Values to determine if the cause is due to intermittent battery failures



```
Diagnostics Data

                     Package A: Package B:
Voltages (V):
 Battery G1:         13.04       12.82
 Battery G2:         13.20       13.02

Currents (A):
 Charging:            0.03        0.01
 Test:               -0.03 FAIL  -0.01 FAIL
 DisCharging:         ---         ---

Charging:                  FAIL        FAIL

Capacity (%):              90.7
Temperature (°C):         28.36 FAIL
AD-converter:                    UK
Shutdown:                        ---
```

O_2 1/min 1.5
N_2O 1/min 4.2
Sevoflurane % in fresh gas 1.5
cmH$_2$0 Ppeak 20 Pplat 20
Peep ---
Minute Volume 1/min 5.0
Tidal Volume ml 500
Insp. Pause % 25
Resp. Rate 1/min 10
I:E Times s insp 2.0 exp 4.0
I:E Ratio 1:2.0
Set PEEP cmH$_2$0 OFF

Figure 55 **Battery diagnostic page**

Most typical battery problems and solution

Symptom	Error message	Cause	Action
Battery failure After long storage	HW battery A1/A2 or B1/B2 fail	One of the four batteries differ more than 0.5 V	Discharge/Recharge the batteries. Replace battery Replace battery charger board
Battery failure (intermittent)	HW battery A1/A2 or B1/B2 fail	One of the four batteries differ more than 0.5 V	Replace battery charger board Replace battery
Battery failure (with new batteries)	HW battery A1/A2 or B1/B2 fail	One of the four batteries differ more than 0.5 V	A) Discharge/Recharge the batteries B) Replace battery
Battery failure	HW run cur A/B fail	During battery power the current drawn from battery pack A / B is < 0.1A	Perform Battery test Replace battery charger board Replace battery
Battery failure	HW test cur A/B fail	During battery test the current drawn from battery pack A / B is > 0.3A	Perform Battery test Replace battery charger board Replace battery

Verifying the operation by functional check and manual battery test

To test the condition of the battery system while the ADU runs on main power go the battery diagnostic page and select ‘Start Test’. Watch all four voltages, they should drop towards 13V. Now select ‘Stop Test’ and watch the charging currents, they should increase to 0,45 - 0,55 A for a short period and then go back to normal charging which is 0,01 to 0,05A for fully charged batteries. When you run this test the front of the charger board will get warm because the resistors used to load the batteries during the test is mounted against the front.

NOTE: This test does not work if you run the unit with battery power

If no charging occurs or if it is wide out of range replace the battery charger board first.

Typical diagnostics values

Below are figures from the diagnostic page that can be used to compare values from the troubleshooting

A) Typical values for an ADU with fully charged batteries running on mains

Voltages (V): 13 - 14 V

Charging: 0,01 - 0,05A *)

Test: 0,15A - 0,19A

Discharging: - - -

Capacity (%): Over 100, usually between 110 and 120%

Temperature (C): 24 - 30 degrees

*) Because of the resolution of the AD converter sometimes a small negative charging current can be displayed (-0,01A).

B) Typical values for an ADU with empty batteries that just started to charge

Voltages (V): 11 - 12 V

Charging: 0,45 - 0,55A

Test: 0,15A - 0,19A

Discharging: - - -

Capacity (%): below 0 usually between -20 and -30%

Temperature (C): 24 - 30 degrees

C) Typical values for a fully charged ADU that has just started to run on batteries

Voltages (V): 12,2 – 12,6 V

Charging: - - -

Test: - - - *)

Discharging: 0,9 - 1,1 A

Capacity (%): - - -

Temperature (C): 24 - 30 degrees

*) No battery test is performed when the ADU runs on batteries

Intermittent battery failures

A typical reason for a ‘Battery failure’ message is that one of the four batteries differs more than 0,5 volt from the average voltage of all four batteries. This does not necessarily mean that a battery is bad. We have noticed that batteries tend do part after some time or when they are brand new as is the case when they are changed in the three year service. Also when the ADU runs on batteries and they are almost depleted they start to differ quite much in the voltage the last five minutes before the ADU turns off.

Verify that differing batteries do not cause the intermittent problems by performing,

Discharge/recharge cycling test

Run the ADU on batteries until it turns itself off and then let it recharge. Observe that the discharge current for each pack is about 1A and that the charge current is 450 to 500 mA. Repeat this cycle if necessary. This will level out the differences in the batteries. This test is recommended when new batteries are installed.

NOTE: When replacing batteries in ADU all 4 must be replaced at the same time. Batteries supplied by Datex-Ohmeda should always be used in ADU, because we are testing and selecting the batteries to each others. ADU problems due to locally purchased batteries we do not take any responsibility for.

Unexpected reset

In a reset condition, the display shows the message ´System failure - Unexpected Reset, please call for service´.

If an Unexpected reset occurs the Electronic Ventilator and the Fresh Gas Control units continue to deliver gas as set, but you will be unable to adjust the ventilator settings. Fresh gas flows and anesthetic agent settings can be adjusted, but the settings are not displayed on the screen.

How the reset system of the ADU works

When an ADU is started the following happens: As soon as power is applied the watchdog (located at the Digipower board) activates the reset signal to the CPU. When the +5V line rises above 4,65V an internal timer in the watchdog keeps the reset active for 200 ms to ensure that the CPU will be properly reset after power up. When the main SW starts to execute it sends a start command to the A-EV1. If main SW gets a good response from the A-EV1 it continues with the start-up of the ADU. However if it receives a message from the A-EV1 saying that it is already running, this is interpreted by the main SW as an error. Main SW should start the A-EV1, if it is already running this is an indication that the CPU has done a warm start. This will result in the error messages on the screen and prevent further operations of the ADU. During normal program execution main SW must do a watchdog kick at least once every second to prevent it from doing a reset of the CPU.

Display description if a reset occurs

When a reset condition occurs, the ADU displays the following:

1. The screen blanks out.
2. After approximately 10 seconds, the “Datex-Ohmeda” is shown.
3. After another 20 seconds, the screen will appear as if in a normal start-up.
4. After another 20 seconds, the message “System Failure - Unexpected Reset, Please call for service” appears in red.

Service recommended actions if a reset occurs

- Check service error log
- Check Voltages on diagnostic pages
- Run HW watchdog test from service page if test fails replace.
  - A. Replace the B-CPU board and repeat the test.
  - B. Replace the Digipower board and repeat the test.
- On the B-CPU2 board check that the SW cassette is correctly installed and that the insulation is present.

Inspection of the SW cartridge insulation

CAUTION Always use anti-static protection.

To verify that the main software cartridge has the plastic insulation sheet installed:

1. Turn the ADU off and disconnect the power cord.
2. Disassemble the back cover. Make sure you use anti-static protection.
3. Remove the two screws for the main software cartridge and pull out the CPU board.
4. Check that the insulation sheet is installed. If you not can decide if the insulation sheet is present remove the two screws securing the software board to the cartridge and slide it out as figure below.
5. If the insulation sheet is not present, contact ADVent BA HelpDesk for further assistance.
6. Reassemble in reverse order.
7. Turn the ADU on and check that the unit passes the self-check.
8. Perform a System check.

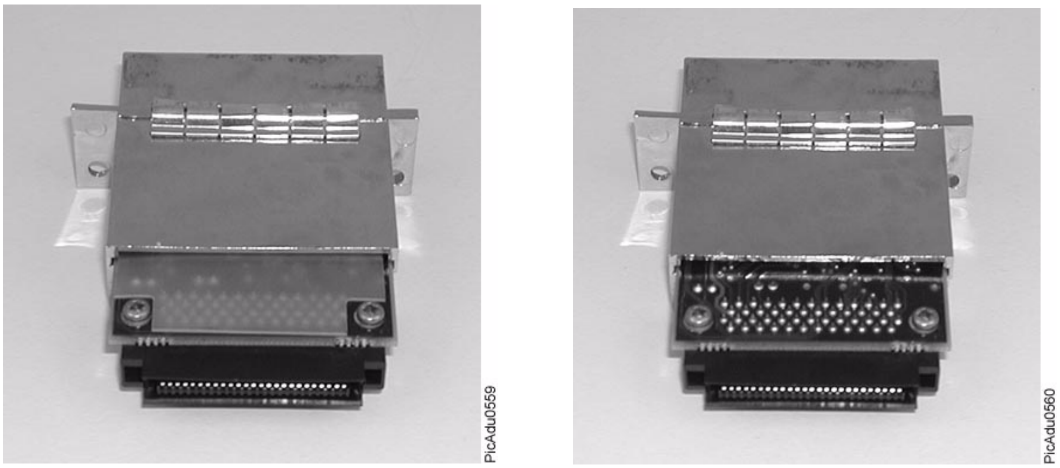
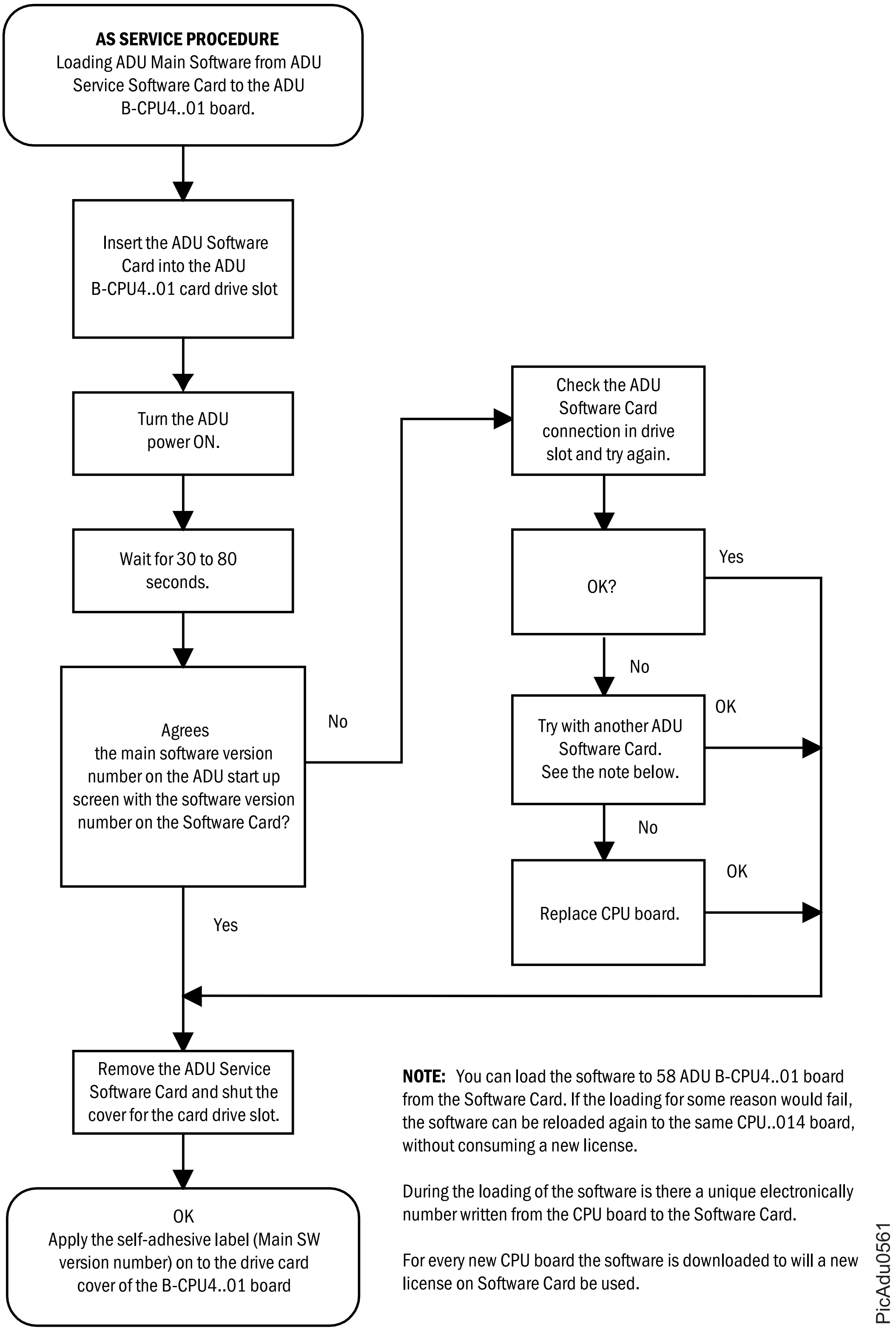


Figure 56 Casette with insulation (left) and without insulation (right)

Trouble shooting PCMCIA Card


AS SERVICE PROCEDURE
Loading ADU Main Software from ADU Service Software Card to the ADU B-CPU4..01 board.
Insert the ADU Software Card into the ADU B-CPU4..01 card drive slot
Turn the ADU power ON.
Wait for 30 to 80 seconds.
Agrees the main software version number on the ADU start up screen with the software version number on the Software Card?
No
Check the ADU Software Card connection in drive slot and try again.
OK?
Yes
No
Try with another ADU Software Card. See the note below.
OK
No
Replace CPU board.
OK
Yes
Remove the ADU Service Software Card and shut the cover for the card drive slot.
OK
Apply the self-adhesive label (Main SW version number) on to the drive card cover of the B-CPU4..01 board
PicAdu0561

NOTE: You can load the software to 58 ADU B-CPU4..01 board from the Software Card. If the loading for some reason would fail, the software can be reloaded again to the same CPU..014 board, without consuming a new license.

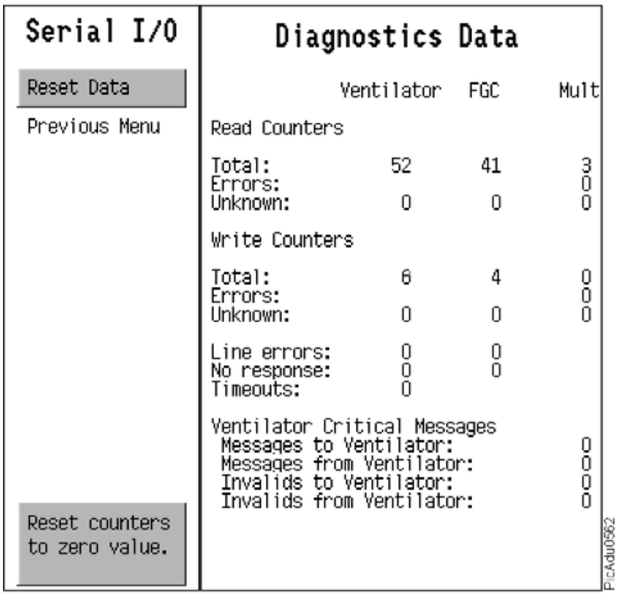
During the loading of the software is there a unique electronically number written from the CPU board to the Software Card.

For every new CPU board the software is downloaded to will a new license on Software Card be used.

Figure 57 Troubleshooting PCMCIA Card

Diagnostic menu layout Serial I/O

This page is used for software validation only.


Serial I/O
Reset Data
Previous Menu
Reset counters to zero value.
PicAdu0562

```
Diagnostics Data

                    Ventilator   FGC      Mult
Read Counters

Total:                  52        41        3
Errors:                                     0
Unknown:                 0         0        0

Write Counters

Total:                   6         4        0
Errors:                                     0
Unknown:                 0         0        0

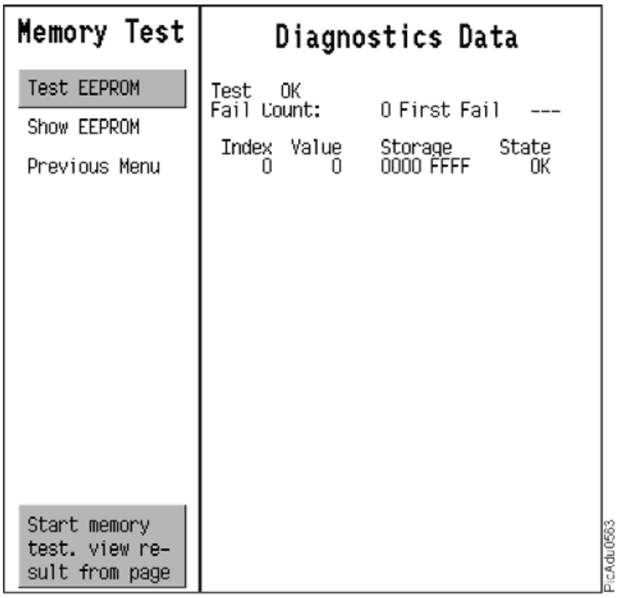
Line errors:             0         0
No response:             0         0
Timeouts:                0

Ventilator Critical Messages
 Messages to Ventilator:                    0
 Messages from Ventilator:                  0
 Invalids to Ventilator:                    0
 Invalids from Ventilator:                  0
```

Figure 58 Diagnostic menu

Diagnostic menu layout memory test

This page is used for software validation only.


Memory Test
Test EEPROM
Show EEPROM
Previous Menu
Start memory test. view result from page
PicAdu0563

```
Diagnostics Data

Test   OK
Fail Count:       0 First Fail   ---

 Index  Value    Storage     State
    0      0     0000 FFFF      OK
```

Figure 59 Diagnostic menu

Troubleshooting LCD display D-LCCADU

Problem	Cause	Treatment
No image on screen and no backlight.	No power or loose interface cable.	Check interface cable.
No image on screen, backlight on.	Cables may be loose. Display controller board or LCD Interface board failure.	Check the items. Replace the board(s) if necessary.
Vertical stripes on right side of screen continuously.	Jumpers in display controller board not positioned correctly.	Check the jumpers. See Installation Manual for reference.
Unstable image.	+5 V unstable. Loose cable. Jumpers in display controller board not positioned correctly or board failure. LCD Interface board failure.	Check cable connections. Check jumper positions. Check the board(s) and replace if necessary
Backlight flickering or dim.	Backlight connector failure or lamp/LCD Interface board failure.	Check the connector. Check the lamp/ LCD Interface board failure.

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SPARE PARTS A-ELEC

General

Available spare parts are found in lists as well as on exploded views at the end of the section.

* Parts compatible with the ADU, S/N: 293001-294000, 981001-981110

Table YES (Y) = To replace the spare part the A-ELEC should be removed from frame.

Table NO (N)= Spare part can be installed without removing the A-ELEC from frame.

XX = Depending where installed.

Inside A-ELEC

Item	Item description	Order No.	Y	N
1	Mains board	895378	X	
2	Rectifier board	892872*	X	
3	Screws M3x8 for Mains board, Battery charger board and EMC grid plate.	61722	X	X
4	Fuse holder Mains board	511790	X	
5	Dust filter	*871558		X
6	Fuse; Battery charger board T4A/250 V	51134		X
8	Screw M 3x6	61721	X	X
Fuse for item 8	Mains Fuses T5A (110V)	511382*		X
Fuse for item 8	Mains fuses T2,5A (230V)	511180		X
9	Toothed washer for M3	63611	X	X
10	Software cartridge for B-CPU2, Main Software software version (contact D-O for latest version available)	XXXXXXX		X
11	Audio amplifier board	*881794	X	
12	Mother board	889125	X	
13	Battery charger board	896975	X	
14	Digipower board 3	890483		X
15	B-CPU4 board(replaces B-CPU2, which no longer is availble)	8502841		X
16	Video Controller board	B-DISP*		X

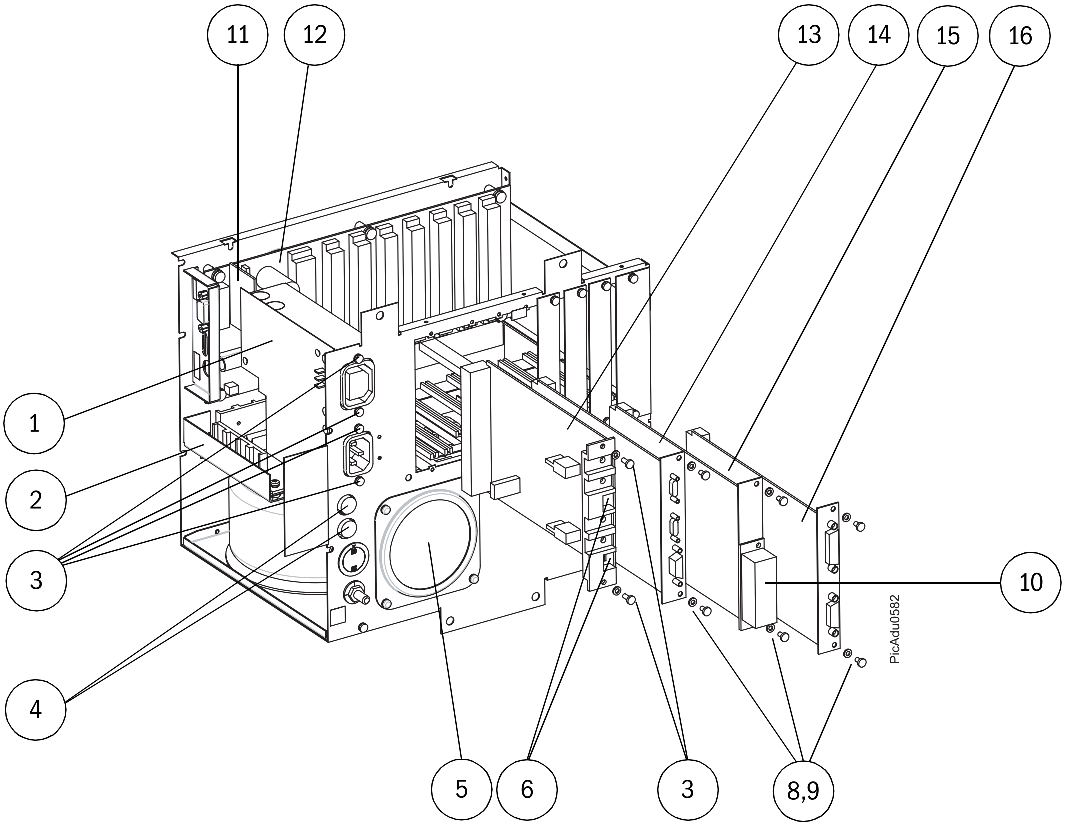
11
12
13
14
15
16
1
2
3
4
10
PicAdu0582
5
6
3
8,9

Figure 60

PCMCIA card

Item	Item description	Order No.	Y	N
1	ADU PCMCIA Service Software Card with Main SW XX For installation of ADU Main software on B-CPU4..01. (contact D-O for latest version available)	XXXXXXX	X	

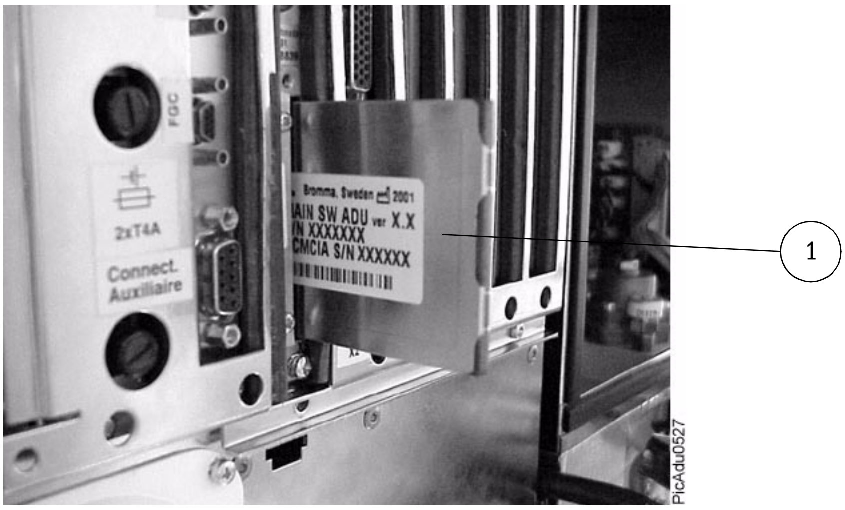
FGC
2xT4A
Connect.
Auxiliaire
Bromma, Sweden 2001
MAIN SW ADU ver X.X
S/N XXXXXXX
PCMCIA S/N XXXXXX
1
PicAdu0527

Figure 61 The PCMCIA card

Battery tray

Item	Item description	Order No.	Y	N
1	Battery, lead-acid 12V, 2.0 Ah (includes 4 pieces)	*891389	X	
2	Battery cable BATT A	*882396	X	
3	Battery cable BATT B			
4	Temperature cable TEMP A	*882397	X	
5	Temperature cable TEMP B			

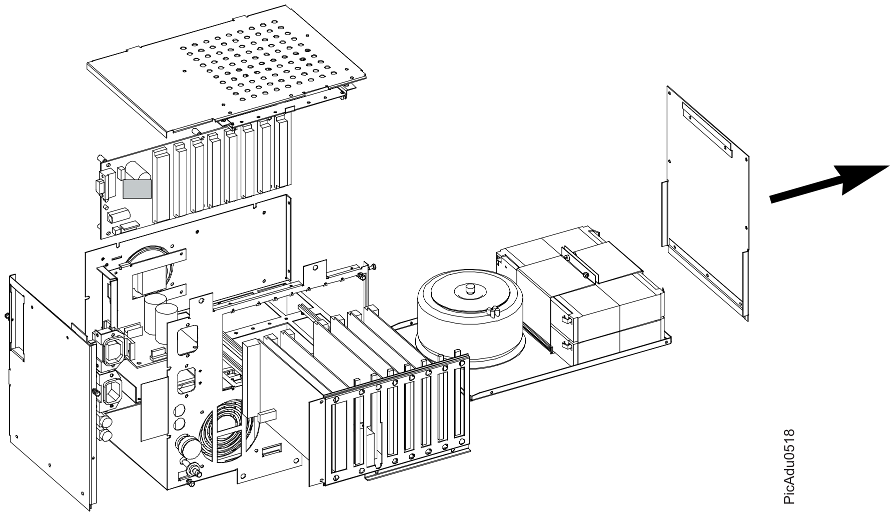

Figure 62 **A-ELEC exploded view**

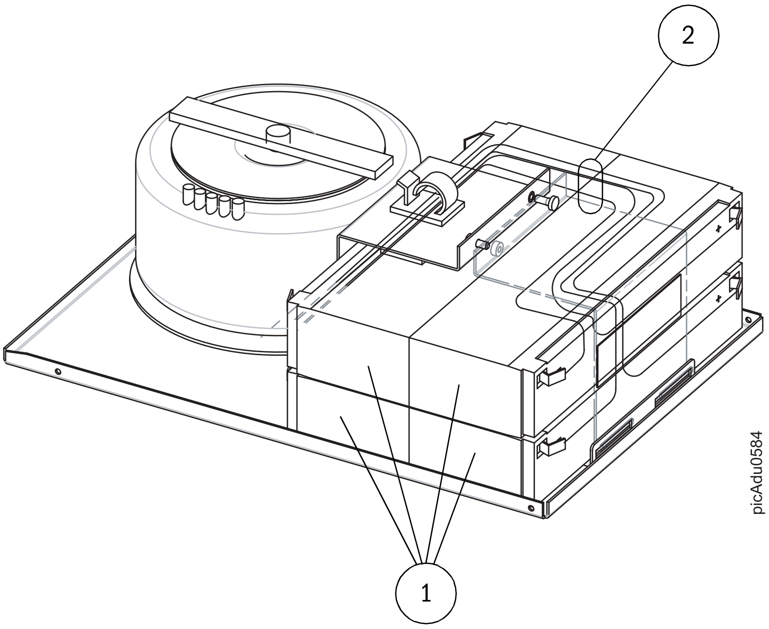
2
1
picAdu0584

Figure 63 **Transformer unit**

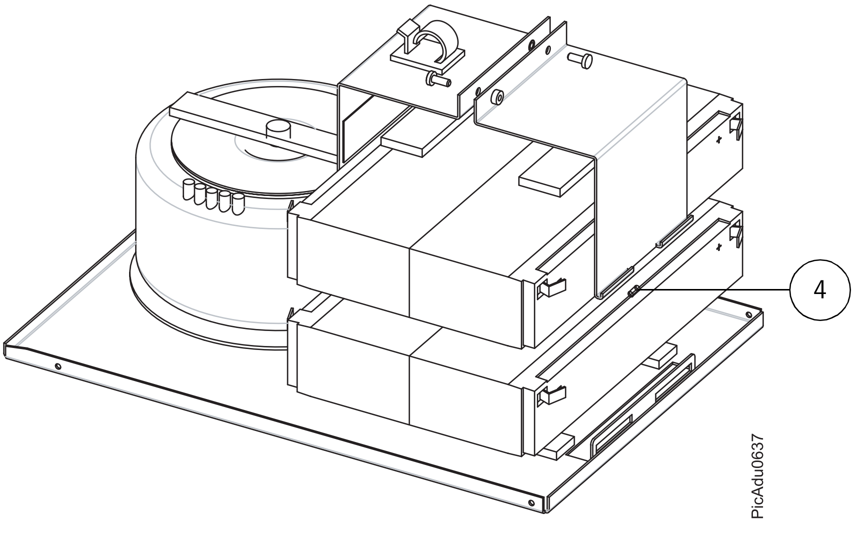
4
PicAdu0637

Figure 64 **Transformer unit**

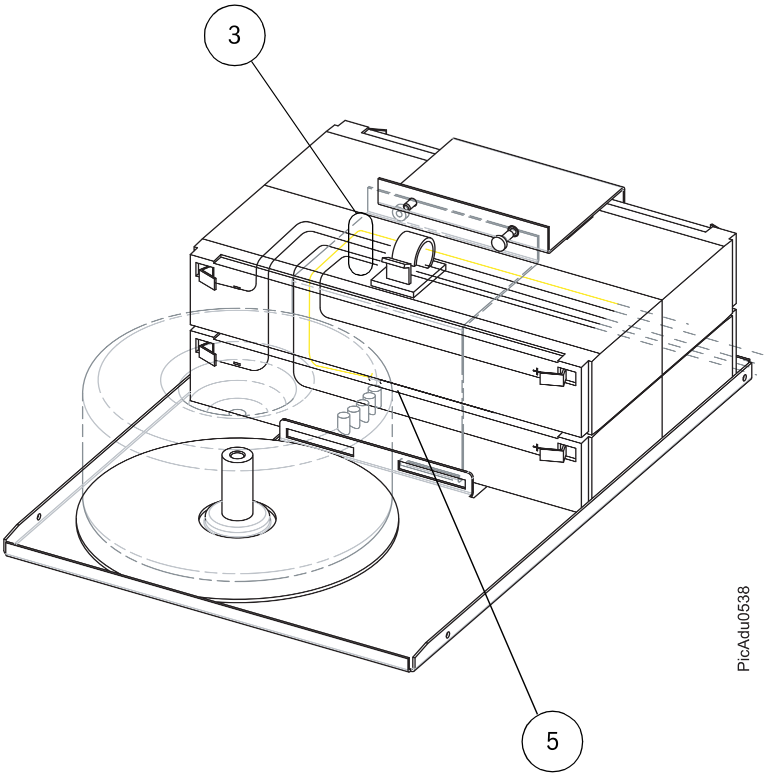
3
5
PicAdu0538

Figure 65 **Transformer unit**

Fan and loudspeaker

Item	Item description	Order No.	Y	N
1	Loudspeaker	890486	X	
2	Fan	890485	X	

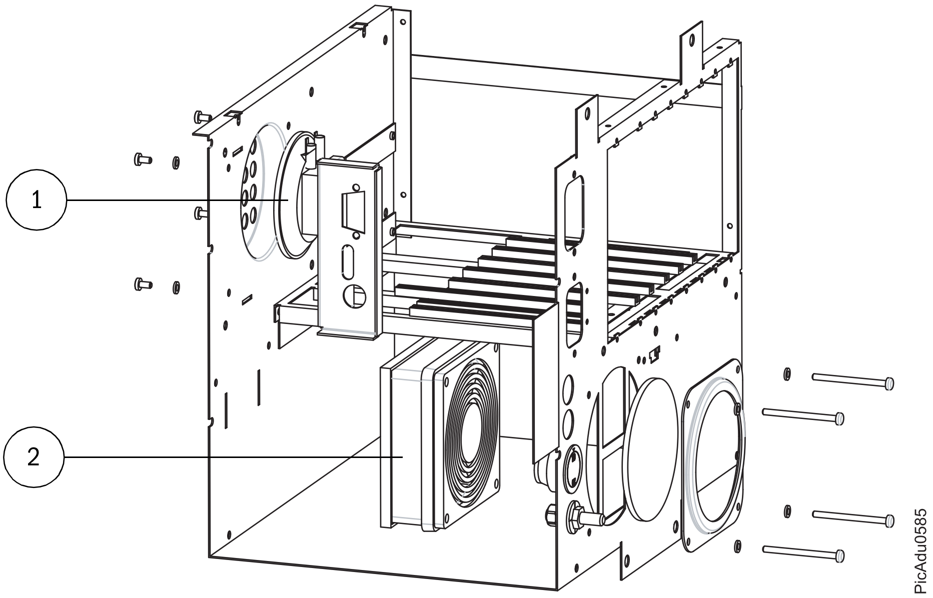
1
2
PicAdu0585

Figure 66 **Fan and loudspeaker**

Rectifier board fuse

Item	Item description	Order No.	Y	N
1	Fuse; Rectifier board, T8A 250 V	511383	X	

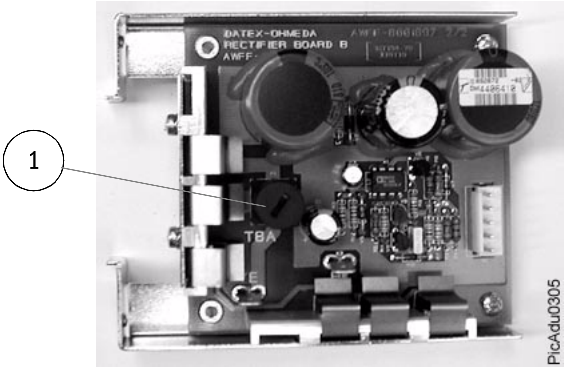
1
DATEX-OHMEDA
RECTIFIER BOARD B
AWFF-
T8A
PicAdu0305

Figure 67 **Rectifier board fuse**

Mother board fuse and On/Standby switch cable

Item	Item description	Order No.
1	Fuse; Mother board, T3,15 A/250 V	51119
2	On/Standby switch cable	890480

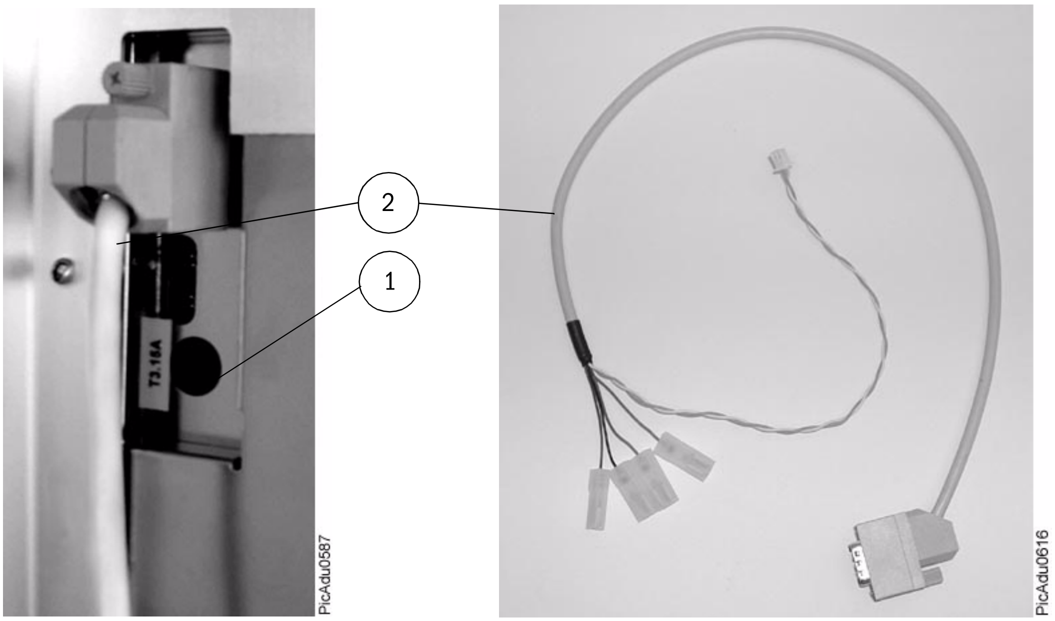

Figure 68 Mother board fuse and On/Standby switch cable

External Outlet Box A-EO

Item	Item description	Order No.
1	Electrical Outlets (complete)	A-EO
2	Power cord; between A-ELEC and A-EO	894340
3	Fuse holder for External Outlet Box	51153
Fuse for item 3	Fuse T2,5AT (220V)	511180
Fuse for item 3	Fuse T5A (110V)	511382

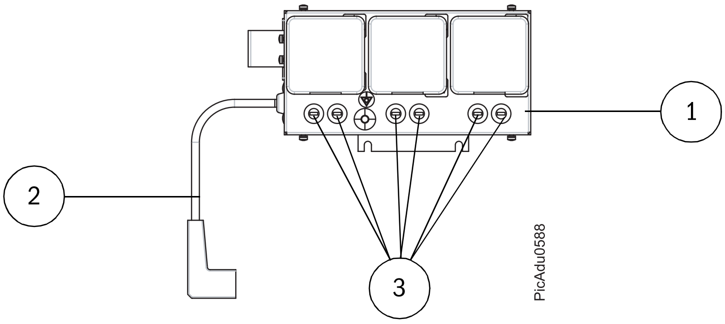

Figure 69

LCD display, D-LCCADU -XX -00, -01

Repairs for the display D-LCC10W are outlined in the *"Technical Reference Manual"* for the Datex-Ohmeda Anesthesia Monitor.

Item	Item description	Order No.
	D-LCCADU display complete.	D-LCCADU
1	Membrane keyboard, horizontal	883487*
2	Membrane keyboard, vertical	893257
3	Front panel sticker / horizontal	see next table
4	Front panel sticker / vertical	see next table
5	Command board PCB	894173 1)
-	Command board software	887874
6	LCD display gasket	890123*
7	LCD display shield	892677
8	LCD display unit, complete	891571
9	LCD display (contains backlight)	572788
-	Replacement fluorescent lamp for LCD display 572788	*572791
10	Adapter unit	891397
11	Inverter cable	891970
12	Adapter board,	892424
13	Insulation plate for 892424	891975
14	Connector board LCD	892421
15	Rotary wheel	879872*
16	ComWheel cover and spring	879191*
17	Inverter shield	892677
18	Rear cover	893699
19	Connector cover	893259
20	Inverter for LCD display 572788	572789
-	Display cable for D-LCCADU	890481
-	Display cable for D-LCC10W	888525

1) The Command board 894173 can only be used as a replacement together with Command board software 887874

D-LCCADU front panel stickers

Adaptation	**Item 3 horizontal**	**Item 4 vertical**
	Order No.	**Order No.**
English	898341	898353
Finnish	898347	898360
German	898351	898354
Spanish	898344	898357
Swedish	898348	898361
Danish	898350	898363
French	898342	898355
Dutch	898343	898356
Italian	898345	898358
Norwegian	898349	898362

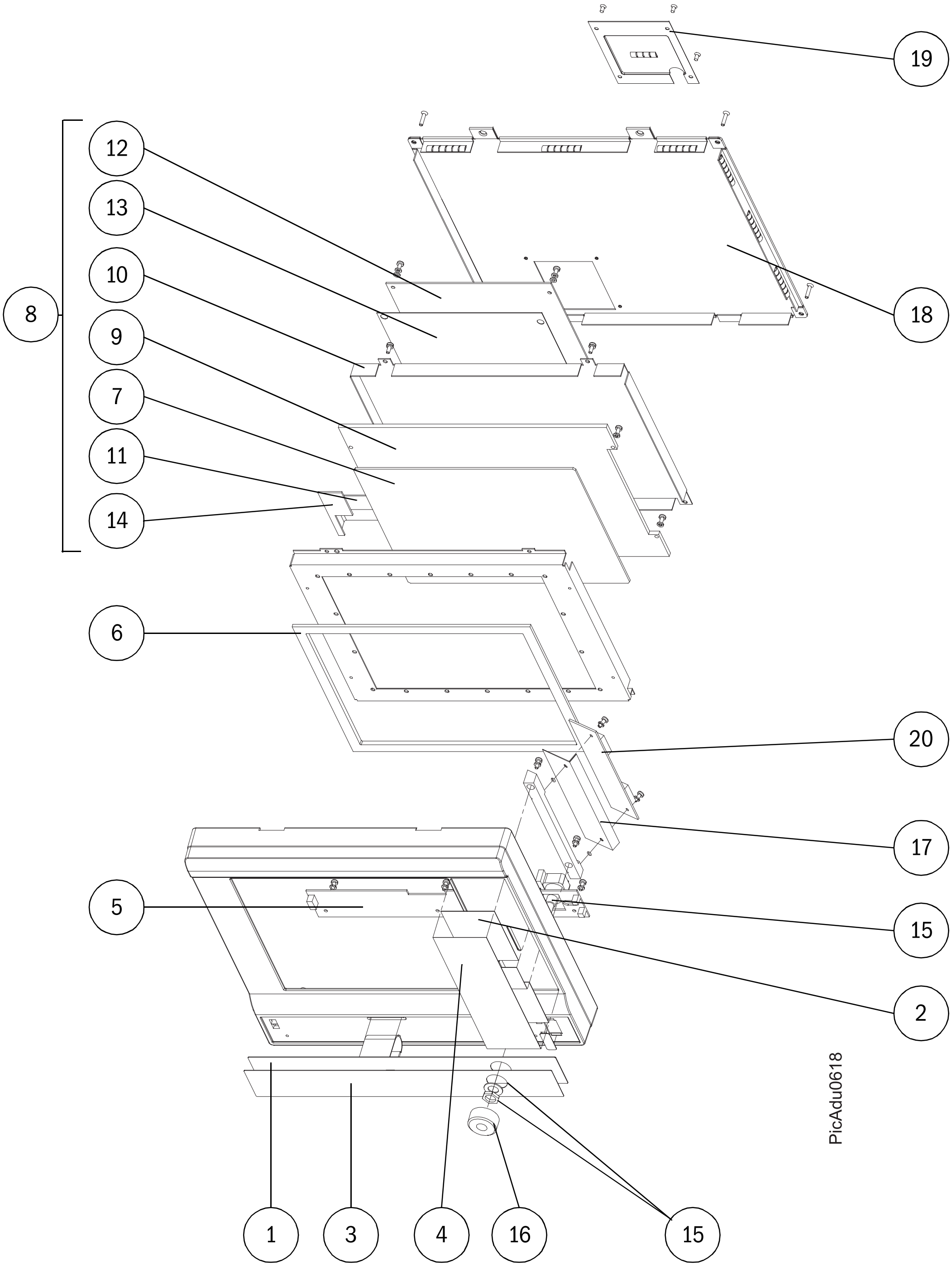
19
12
13
10
8
9
7
11
14
18
6
20
17
5
15
2
PicAdu0618
1
3
4
16
15

Figure 70 **Exploded view of D-LCCADU**

Miscellaneous parts

Item	Item description	Order No.
-	Power cord, 230 V	*54563
-	Power cord, 110 V	889487
-	Serial cable EV1 and A-ELEC / FGC1 and A-ELEC (1 piece)	890484
-	Static RAM B-CPU4-01 board. (Fits also B-CPU2-01)	197230
-	Screws M3x12 (EMC grid plate one screw)	61736

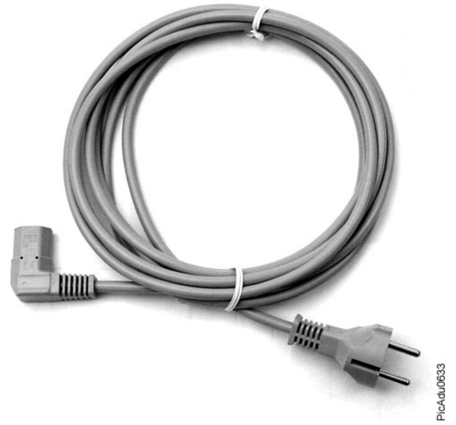

Figure 71 **Power cord 230 V**

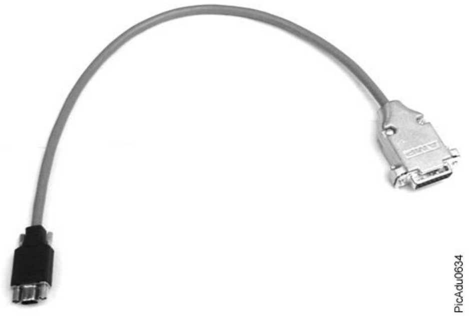

Figure 72 **Serial cable**

D-LCC 10 W panel stickers

Item	Item description	Order No.
-	AM LCD front panel sticker Horizontal (English)	898328
-	AM LCD front panel sticker Horizontal (German)	898329
-	AM LCD front panel sticker Horizontal (French)	898330
-	AM LCD front panel sticker Horizontal (Dutch)	898331
-	AM LCD front panel sticker Horizontal (Italian)	898332
-	AM LCD front panel sticker Horizontal (Spanish)	898333
-	AM LCD front panel sticker Horizontal (Finnish)	898335
-	AM LCD front panel sticker Horizontal (Danish)	898338
-	AM LCD front panel sticker Horizontal (Swedish)	898336
-	AM LCD front panel sticker Horizontal (Norwegian)	898337